THE
VETERINARY JOURNAL

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Biography

ALFRED W. NOEL PILLERS, F.R.C.V.S., D.V.S.M.

OUR frontispiece this month is the photograph of Capt. A. W. Noel Pillers, F.R.C.V.S., D.V.S.M., who was appointed earlier in the year to the post of Chief Veterinary Officer for Liverpool in succession to Mr. T. Eaton Jones, F.R.C.V.S., retired.

Capt. Pillers was born in Bristol in 1883, and passed from Redcliffe and the Merchant Venturers College to the Royal Veterinary College, London, where, in the course of a distinguished career, he gained the Firzwygram Prize, qualifying in 1906, and being appointed as one of the College tutors. In 1907 he was appointed assistant to the Horse Superintendent of the Great Central Railway, being subsequently moved to Sheffield as District Veterinary Surgeon for the Company. He joined the Corporation of Liverpool Veterinary Department in 1911, and has served the city since that date, with the exception of a break during the War, in which he was twice mentioned in dispatches.

Capt. Pillers has been on the panel of Examiners for the Fellowship of the Royal College and of the Royal Sanitary Institute for several years, and is honorary lecturer in clinical veterinary parasitology at the Liverpool School of Tropical Medicine. The Lancashire Veterinary Medical Association has twice claimed him as President, and he has been its treasurer since 1924. He is well known as an author of original work in subjects pertaining to public health, parasitology, diseases of the horse's foot, and diagnostics generally. THE VETERINARY JOURNAL has been fortunate enough to secure articles from his pen on many occasions, for Capt. Pillers is one of the ablest clinicians in the profession, a leader in public health activities, and a parasitologist of world-wide repute.

Unlike several of his student contemporaries who are now shaping the destinies of the profession, he has not yet sought election to the Council of the Royal College, though few could be better fitted for the honour. His force of character and his fearless passion for rectitude often bring him into conflict with his fellows on questions of professional policy, and when he hits, he hits hard; but even his

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opponents admit that his whole desire is the welfare of the profession. Those who judge him by his public utterances alone are probably unaware of the kindly side of his nature, which makes him a wise counsellor and friend to the countless young men who go to him in trouble, and are never refused help and advice. The City of Liverpool is fortunate in having the services of such a competent veterinary adviser, and the profession is proud to number such a man among its members.

Editorial

A MUCH NEGLECTED OUTLET FOR VETERINARY ENTERPRISE.

THE appearance of a special number of the Journal devoted entirely to the diseases of the small fur-bearing animals, and birds other than poultry, will draw the attention of the members of the profession to another outlet, not only for scientific research, but also as an additional means of income for the practitioner who will take the trouble to make himself *au fait* with the epidemic diseases of these smaller patients.

Up to the present, except for one or two practitioners who stand out as notable instances of men who have wisely seized hold of their opportunities, the prescribing for the ailments of these smaller animals, and also of cage birds, has been in the hands of the empiric, but a brief perusal of the articles which are to be found in this month's pages illustrates clearly the opportunities which present themselves for the discovery of scientific facts, which may also be applied to the control of epidemics not only in the larger animals, but also in man. The articles in this issue are ample evidence of the importance and value of the subject; and a further list, which was crowded out, will appear in the January issue. This is definitely a veterinary task, the need is pressing, and it only wants financial encouragement to enable it to be undertaken by veterinary workers.

THE PREVENTION AND CURE OF DISTEMPER.

IT is better to "prevent" than to "cure," but the persevering efforts of Laidlaw, Dunkin, and Dalling, on the dog and the fitch, have successfully carried certain laboratory methods into such practical shape that they can now be applied "in the field" both in a prophylactic sense and also (in the early stages) as a curative. The veterinary profession owes much to them, and also to the Editor and Proprietors of the *Field* newspaper, for the splendid way in which the appeal (originally started in combination with THE VETERINARY JOURNAL) was so tactfully handled that the £25,000 which was originally asked for was obtained; and not only obtained, but carefully and judiciously allotted out in the work of research so that it lasted a sufficiency of time to enable the workers to see the result of their labours.

The final report (which arrived too late for insertion in this issue) of the Distemper Council will be printed in the January issue; and to all our readers, especially the practitioner, it will prove interesting and valuable reading. It is a further illustration, too, of the wisdom, where a knowledge of the diseases of animals is concerned, of the value of collaboration between the laboratory and the practical worker.

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General Articles

THE NEED FOR VETERINARY SERVICE FOR THE SMALL FUR-BEARING ANIMALS, AND BIRDS.

By TOM HARE, M.D., B.V.Sc., M.R.C.V.S.

Department of Pathology, Royal Veterinary College, London.

At the institution of collegiate veterinary education in Great Britain, in 1791, the study of disease was confined to the horse. Within the next fifty years the diseases of cattle were added to the curriculum, which by the end of the nineteenth century was enlarged to embrace disease in sheep, swine, dogs and cats. During the last twenty years increasing attention has been given to poultry diseases. Each of these additions to the teaching curriculum has been made in response to a national need and to the nation's recognition of the veterinary profession as its responsible agent for the treatment and prevention of disease in its livestock.

After the Great War, the fur-bearing animal and bird fancies rapidly increased in numbers and in economic value; as a consequence many fanciers began to appreciate the need for scientific treatment and prevention of the diseases causing heavy losses among their stock. These views were made known to Mr. Henry Gray, M.R.C.V.S., who is widely respected by the fanciers as the pioneer student of disease in the small fur-bearing animals and birds of Great Britain. Five years ago Mr. Gray introduced representatives of the fancies to members of the staff of the Royal Veterinary College. From many conversations it became evident that the fancies required, firstly, the services of local veterinary practitioners for the treatment and prevention of disease and, secondly, the establishment of laboratories for research and for assistance of veterinary practitioners.

Recognising not only the urgency of the need but also the unpleasant fact that Great Britain, unlike so many Continental nations and the U.S.A., had made no special provision for research into the diseases of small fur-bearing animals and birds, the Principal and Governors of the Royal Veterinary College issued an appeal for funds to endow a research laboratory. Whatever efforts may be made by the London school it is obvious that the provision of veterinary services for the fancies requires, firstly, adequate numbers of veterinary surgeons preparing for private practice in the small fur-bearing animals and birds and, secondly, adequate teaching and research facilities in all the veterinary schools. A brief outline of the present and potential values of the fancies may provide some surprises to those who have not given much thought to this new problem confronting the veterinary profession.

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The Rabbit.

When the British Fur Rabbit Society was founded fourteen years ago the majority of owners were breeding the " fancy " rabbit for exhibition. However, after the War, the breeding of utility rabbits for wool, fur and meat advanced rapidly, and the owners established their co-operative society for the sale of pelts. The present membership of this society (Fur Board, Ltd.) is about 3,000 registered breeders. In 1929, the National Rabbit Council was founded to co-ordinate the interests of the rabbit industry and to promote scientific research. Between them these three organisations watch over the interests of a young but very active industry possessing approximately 850,000 rabbits. There are large numbers of owners each of whom feed several hundred rabbits, and the stock of some farms number more than a thousand. The current value of the winning exhibition rabbit varies from £10 to £30 each, and of good pedigree utility rabbits from £1 to £3 each. Ordinary meat stock sell at 2*s.* to 3*s.* each wholesale.

By 1928, the sale of pelts by Fur Board, Ltd., increased to £13,356; since then its sales have declined owing to the economic depression and to intensive foreign competition. The Angora wool crop increased from £290 in 1922–23, to £12,520 in 1926–27, when approximately 100,000 Angora rabbits were being fed in this country. In recent years Smithfield market has sold annually from 20,000 to 24,000 cwt. of home-produced wild and tame rabbit carcases, of which appreciable quantities have been the by-product of the fur industry.

The potentialities of the utility rabbit industry can be gauged from Board of Trade returns on the imports into Great Britain. From 1926 to 1930, the average annual value of imported dressed rabbit skins was £914,396, which represents nearly seventy times the value of home-produced pelts, and approximately 25 per cent. of the total value of all furs " consumed " in this country. These imported pelts were derived almost entirely from tame rabbits; the pelts of wild rabbits are not included in the above figures, as they are mainly used for making felt. In 1929, 1,541 cwt. of Angora wool, valued at £120,482, and in 1930, 1,420 cwt., valued at £177,913, were imported, mainly from France. In 1928, the imports of fresh frozen and tinned rabbit flesh amounted to 243,000 cwt., valued at approximately £745,000; and in 1931, 392,437 cwt., valued at £729,220. Thus Great Britain has been paying to the foreigner some £1,500,000 per annum for rabbit products. With some slight fiscal assistance from Government, the leaders of the rabbit industry anticipate that the country's requirements of fur, wool and meat could be supplied largely from home-bred stock. The industry could very quickly expand to an estimated minimum annual value of about £5,000,000; if such a development takes place the rabbit will become one of the principal stock-raising industries of the country.

The Silver Fox.

The silver fox was introduced into Great Britain about twelve years ago; now there are seventy ranches varying in size from 10 to 150 breeding pairs. The value of a pair of good quality foxes varies between £90 and £125. The

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interests of the industry are promoted by the Silver Fox Breeders' Association, whose seventh annual show was held recently at the Royal Agricultural Hall.

Other Fur-bearing Animals.

The British Fur Breeders' Association was formed three years ago to promote the interests of breeders of the blue fox, cross fox, fitch, mink and nutria. The association, with a membership of seventy-five registered breeders, holds its annual exhibition at the Crystal Palace, and organises classes in the Bradford and Edinburgh shows. The average value of good quality breeding pairs of cross fox is £150, blue fox, £90; mink, £25 to £30; nutria, £20 to £25; and fitch, £3 to £4. The association is also conducting breeding experiments with racoon, marten, silver badger and black squirrel. At present cavies have very little value for commercial purposes: they are bred as a hobby and for exhibition by many fanciers, whose interests are catered for by the eleven special breed societies, and by *Fur and Feather*.

The Fancy Mouse.

Four hundred breeders of fancy mice and rats are registered by the National Mouse Club, which is the central organisation of the fancy. On the average the larger breeders keep about 1,000 mice; one member has a stock of 5,000. The values of the best exhibition mice range from 15*s*. to £5 each; 25*s*. is the average price of a well-marked trio. The recent experiments on the use of mice pelts for gloves and fur coats have given satisfaction, and the possibilities of developing the fancy into a branch of the fur industry are being explored.

The Pigeon.

The fancy and racing pigeon have distinct organisations and journals. There are between four and five million racing pigeons in the country; approximately one million rings for young birds are sold each year to registered members of the racing federations. There are 4,000 racing pigeon clubs with a total membership of approximately 80,000 fanciers, and it is estimated that there is an equivalent number of racing pigeon fanciers who have not registered with any of the clubs. Squeakers from well-known lofts are sold at prices ranging from 15*s*. to £5 each. Birds which have accomplished extraordinary performances are frequently sold for £25, £50 and £100 each; £255 is the record price paid for the winner of the National Flying Club's race from San Sebastian. There is a valuable export trade (of which no figures are available), since the British racing pigeon is regarded as the best in the world. The French and American Army Pigeon Services recruited their war stocks in England. There are approximately 90,000 fancy or exhibition pigeons in the country. Prize winning birds sell for £25 to £50 each; higher prices have been paid for exceptional birds.

Cage Birds.

A large variety of British and foreign birds are bred in aviaries and bird-rooms in Great Britain; many fanciers have extensive aviaries housing hundreds of birds; the upkeep of one of the largest private collections is reported to cost

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£10,000 per annum. Many municipalities own large aviaries: those at Nottingham, Liverpool and Darlington are especially well-known and valuable collections. The average selling price of a first class Yorkshire and Norwich canary is £20; budgerigars, £15 each; aviary-bred parrots and parrakeets, £40 to £50 a pair; ordinary stock canaries and budgerigars, about 10*s*. to 15*s*. The export trade in canaries is valued at approximately £50,000 per annum.

Shows and Exhibitions.

The fancies each year organise over one thousand open and members' shows, ranging from the local societies annual to big exhibitions in London, Bradford, Edinburgh, Glasgow, Birmingham and other cities, *e.g.*, 308 for rabbits, 50 for mice, 296 for fancy pigeons, and 600 for cage birds.

The Veterinary Profession's Task.

The small fur-bearing animal and bird fancies, in stocks, foodstuffs and labour, are by no means a negligible source of wealth to Great Britain. Moreover, each of the fancies can truly claim that its stock is the best in the world. When such a national asset requires the aid of veterinary science there is only one reply the veterinary profession can, and assuredly will, give.

It has been indicated above that the treatment and control of disease on behalf of the fancies will require the services of the veterinary practitioner supported by adequate facilities for teaching and research at the veterinary schools. The veterinary practitioner, on account of the essential personal service which only he can give to the individual fancier, is the most important unit in the profession's forces. His services will be required for the surgical and medical treatment of the sick individual; for advice on feeding, hygiene, and prevention of disease; for post-mortem examinations; for certifications of exports, etc. The rabbit industry has already recognised the need of veterinary inspection at shows, and it is anticipated that the initial appointment of a veterinary surgeon to the Bradford Show next January may lead to recognition of the necessity for such an appointment at all the large shows in the country.

When will the services of the veterinary practitioner be sought by the fancier? When he and the fancier have come to know more of one another's interests. With the exception of a relatively small number of members who are fanciers themselves, the veterinary profession has not given much attention to the special requirements, management, feeding, dosage, etc., of the fur-bearing animals and birds. But the author disagrees with those who declare that the veterinary graduate lacks the requisite knowledge for serving the owners of fur-bearing animals and birds, since the principles of physiology, pathology, hygiene, therapeutics and surgery of his present patients are those of the rabbit and canary. Given the will to learn, the veterinary surgeon can quickly attain a measure of confidence in handling the problems of the fanciers by reading the fancy press and such books as are recommended in the appendix to this paper. Additional confidence will be acquired by associating with fanciers in the district, especially

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through membership of their local societies, handling exhibits at their shows, and taking part in their very frequent discussions on disease of their stock.

On their side the fanciers have much to do. Through their press they are being educated to seek the aid of the veterinary practitioner and to invite him to share in the interests of their societies and shows. It should be kept in mind that the fanciers, who represent all grades of society, have had to rely upon the exertions of their own organisations for service on behalf of their diseased stock; consequently their resort to patent medicines and other undesirable measures should be treated sympathetically. In fact the fancier will be persuaded to discard familiar empirical methods only by the dissemination of good-will by his leaders and by the veterinary profession.

Though time will be required to bring about the requisite collaboration, neither the fancier nor the veterinary surgeon can afford to leave "the other fellow" to do the work. The poultry industry was led, by the veterinary profession's indifference to its needs, to institute its own services for the treatment and prevention of disease. It would be well for the veterinary profession and the fancies to ponder over and profit by this serious mistake of the past.

Conclusions.

(1) The leaders have expressed the urgent need for veterinary services on behalf of their fancies and industries. (2) These services are required for a rapidly developing stock industry, which is of great economic value to the nation. (3) The veterinary practitioner, supported by adequate laboratory and teaching facilities at the veterinary schools, is the mainspring of the service. (4) The promotion of friendly relations by veterinary practitioner and fancier is necessary to inaugurate and ensure permanence to a service which is of national importance.

APPENDIX.

Giving literature of value to the veterinary practitioner: (1) Ward, A. R., and Gallagher, B. A.: "Diseases of Domestic Birds," 1920, 14*s*. net. (2) Fox, H.: "Disease in Captive Wild Mammals and Birds," 1923, 60*s*. net. (3) Pickard, J. N., and Crew, F. A. E.: "The Scientific Aspects of Rabbit Breeding," 6*s*. net. (4) McDougall, J. B.: "The Rabbit in Health and Disease," 5*s*. net. (5) Report Proc. Fourth World's Poultry Congress, London, 1931, H.M. Stationery Office, 10*s*. 6*d*. net. The fancy's press advertise a number of handbooks, priced at one to three shillings, which contain very useful information on the management and common ailments of the fur-bearing animals, pigeons, and cage birds.

THE RABBIT INDUSTRY AND VETERINARY SCIENCE: A NEW FIELD FOR PROFESSIONAL SKILL.

The Claims of a Young but Co-ordinated Industry on the Specialised Knowledge of the Veterinary Surgeon.

Contributed by "FUR AND FEATHER."

THE progress of the British rabbit industry has been marked by nothing so much as the almost continuous endeavours to achieve some manner of unity. The earlier of these endeavours aimed solely at the welding together of various

sections *within* the industry ; the more recent have sought to co-operate agencies from *without*. What import this may have for the veterinary profession will be evident from the following brief resumé of the development of the rabbit industry.

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Prior to the War, rabbit keeping was amongst the most popular live-stock hobbies. Its adherents, however, were scattered throughout the British Isles ; the only real unifying force was the rabbit keepers' weekly paper, *Fur and Feather*. Then, with the War, came the cry of " breed rabbits for food," as a result of which the ranks of rabbit keepers were enormously increased.

The War ended. Rabbits for food were no longer a necessity. But it had been discovered that the rabbit had a commercial value other than that of its flesh. There was the fur. Very quickly breeders set about to produce new breeds of rabbit and to import fresh varieties from the Continent. Specialist clubs for each particular breed sprang up and grew rapidly in membership and in power. The foundations of a new home industry were laid.

At an early period the realisation had come that co-operative effort was likely to achieve far more than could be expected from individual breeders, or even from individual specialist clubs. A few of the latter, devoted to the popular fur breeds, threw in their lot together. The amalgamation was a success. From it there was born the organisation which became known as the British Fur Rabbit Society.

The B.F.R.S. was, and is, something more than a co-operative organisation. To some extent it was, and still is, a governing body. Realising how quickly the rabbit fancy and industry were growing, it drew up a code of rules, not only to ensure that rabbit shows should be conducted properly, but also that business should be transacted honourably, and that it should be possible for people to buy stock with a guarantee that it would breed true.

Whilst the B.F.R.S. was carrying on its good work of uniting the breeders of the fur varieties of rabbit, various lesser clubs, each devoted to some particular breed, were also doing excellent service. In addition, too, there had come into being the Fur Board, Limited, a co-operative organisation whose patrons now include Lady Eardley Wilmot, Lady Evelyn Guinness, Lady Steele-Maitland, Lady Watson (a Director) and whose secretary is Captain Brumwell, and which had as its aim the setting up of a buying and selling agency for fur-rabbit products. In this aim it has had much success.

Meanwhile, one or two national clubs were also doing great work of co-operation for Angora breeders. The latter were experiencing a boom period. It lasted until 1928, by which time the number of Angora rabbitries in the country must have been well into the tens of thousands.

In this year was made a great attempt at complete co-operative organisation. A conference was called at Birmingham with the aim of setting up a non-

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legislative parliament for the rabbit world. The idea was that the specialist clubs and the B.F.R.S. should remain supreme in matters of government, but that this proposed parliament should act as a co-ordinating body for all British rabbit breeders. From this conference there was evolved later the National Rabbit Council.

The B.F.R.S., as we have seen, had done a great work of welding together various sections within the rabbit industry. The importance and value of that work cannot be over-estimated. The National Rabbit Council augmented it by bringing together under one head a great many of those who were interested in rabbit pelt production, in wool production, and in purely exhibition rabbit keeping. It found its greatest field of activity, however, not within the rabbit fancy and industry, but outside it.

It was the N.R.C. which was largely responsible for deputations seeking concessions from the Government, from the Railway Companies, from local authorities, and other bodies. It was the N.R.C. which brought the rabbit industry into closer touch with animal breeding research stations, and with agricultural instructors. It is significant, too, that the first Year Book of this Council should contain two articles by veterinary surgeons, that the Council should have a special scientific advisory committee, and that before its first birthday it should have appointed as its veterinary adviser Mr. V. R. Kerr, M.R.C.V.S., D.V.S.M.

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That was the position of the rabbit world at the end of 1928. A great deal has happened since then. The boom of rabbit products, especially of Angora wool products, was followed, as in almost all other industries and hobbies, by a depression. The price of stock fell disastrously ; breeders reduced their rabbitries to a minimum. But they did not dispense entirely with their rabbits. They would seem to have kept their best, and gone on breeding ever better and better stock. That is indicated by what has happened at the greatest of all small live-stock shows, the championship show held at Bradford in January of each year. Here entries almost consistently have mounted ; last year they reached a total of 3,500.

There is little doubt that the rabbit industry has lived through the " rainy days " because of the efforts previously made to build up a co-operative organisation. When world trade depression was at its lowest ebb, *Fur and Feather* still persisted in its propaganda ; the B.F.R.S. still bravely carried on ; the National Rabbit Council still met and pressed forward the claims of the rabbit fancy and industry.

What is the position to-day ? The depression is passing ; ahead there is the prospect of better times—not of the inflated prosperity of the boom period, but a steadier and, one may believe, a more lasting prosperity. The signs of it are so clear that one of the most astute and oldest Angora rabbit breeders, Lady George Carter, is at present contemplating setting up a stud of 5,000 head.

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And there, for the present, ends the story of the effort at co-operative organisation in the rabbit fancy and industry. Co-operation has not been so easy of attainment as would appear from this bare story. There has been (as there always will be) much conservatism to overcome. But though the story is ended, one may be permitted in this Journal to ask a vital question. It is this: What are to be the relations between this young and now reviving industry and the veterinary profession?

Gestures have already been made by rabbit breeders, many of whom realise that without veterinary research the rabbit industry cannot progress. If the rabbit industry is to go forward (some of them have argued) larger and larger studs must be kept together, possibly not in hutches as previously, but in " flocks " under a colony system. But what of the dangers of disease under such communal conditions? What of coccidiosis, snuffles, and other ailments?

Those who so argue are the breeders who are whole-heartedly in support of Dr. Tom Hare in his efforts to have established at the new Royal Veterinary College a special department for the study of furred and feathered creatures. But there are others who are yet to be converted. What is to be done about them?

Veterinary surgeons can assist in this work, and at the same time help themselves. They can act on a suggestion recently put forward in an article in *Fur and Feather* by Mr. W. Watmough. It was this: " At many rabbit shows, especially the big ones, there is need of a veterinary surgeon to act in a similar capacity to the ' vet.' at a dog show. The surgeon would not have to examine every animal, but stewards would draw his attention to any which seemed ' off colour.' It might be a thankless task for this hon. veterinary surgeon, but it would certainly help to create a better appreciation of the work which the veterinary profession can do—if it is but given a chance—for the rabbit fancy and industry."

Now who amongst veterinary surgeons will give this a trial?

SOME DISEASES OF FUR-BEARING ANIMALS.

By T. DALLING, M.R.C.V.S.

Wellcome Physiological Research Laboratories, Beckenham, Kent.

THE raising of fur-bearing animals under ranch conditions is increasing in this country, and it behoves veterinarians to become acquainted with the various diseases from which they suffer, for as the numbers of animals increase, so will disease inevitably become more prevalent and veterinary surgeons will be required to give advice more and more. It is hoped that investigation into the diseases of these animals will progress side by side with the development of the industry, so that adequate means of prevention and treatment will be available. A considerable amount of knowledge on the subject has already been accumulated, as

can be gathered from a perusal of recent British and American scientific literature. This paper deals with conditions, epidemic in nature, with most of which we have had some first-hand knowledge, *viz.*, canine distemper in the fitch, leptospiral jaundice in the fox, and " distemper " in the fox.

Canine Distemper in the Fitch.

The susceptibility of the ferret to canine distemper virus was demonstrated by Dunkin and Laidlaw (1926). The fitch is closely allied to the ferret, and because of the value of its pelt, is bred and reared in some districts on an extensive scale. In our experimental work on canine distemper we make use of numbers of ferrets, and on occasion animals which, as far as we could judge, were really fitch or fitch crossed with ferret were supplied to us. We observed that these animals could be used equally as well as the ferret for our various tests, and so we got in touch with a fitch breeder, who gave us facilities to examine his animals for susceptibility to infection with canine distemper virus, and to experiment further with a view to their immunisation. The results of this investigation were published last year (Dalling, 1931), and were that the fitch is susceptible to infection with canine distemper virus, and can be immunised against artificial and natural infection by the injection of attenuated virus in the form of spleen emulsion of infected ferret treated with formalin, followed in about ten days by a small dose of active virus. Since the publication of that paper we have had experience in the active immunisation of the fitch against natural infection by the above method, and the reports we have received indicate that the method is satisfactory. Laidlaw and Dunkin (1928) showed that dog tissue vaccine could be used for the immunisation of ferrets only if at least three injections were given prior to the dose of virus, otherwise the immunity produced was insufficient to prevent infection occurring when the virus was injected. Most of our experiments confirm this finding, but occasionally we have found that one dose of dog tissue vaccine will so immunise a ferret that it can withstand a full infecting dose of virus. The use of dog tissue, however, is not to be recommended.

We have no experiences which justify the use of anti-canine distemper serum in the treatment of fitch actually affected with distemper, but we have experience of its value in in-contact cases, provided it is injected before symptoms of distemper are observed. In this connection, Cunningham (1932) records his experiences of the use of anticanine distemper serum in the fitch. He records that in treating an outbreak of distemper in fitch it was valueless as a curative agent, but, " on the other hand, very few fitch receiving the serum as a prophylactic developed any symptoms of the disease."

We have not had the opportunity of studying canine distemper in the mink, but Law (1931) records that the mink also is susceptible to the virus, and that " results in the field show sufficient promise to justify the use of the Laidlaw-Dunkin vaccine and serum in the prevention and cure of the disease."

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Leptospiral Jaundice in the Fox.

Okell, Dalling, and Pugh (1925) demonstrated that infective jaundice (yellows) in dogs was caused by infection with leptospira icterohæmorrhagica, and they subsequently showed that serum and vaccine were useful in prophylaxis and treatment. Since that time much information has been accumulated following the use of these products in the field, and their value has been established. Dunkin (1926) first observed that an English red fox presenting symptoms of " yellows " was infected with leptospira, and recently we have successfully infected a red fox by the injection of an emulsion of guinea-pig liver, the animals having died from leptospira infection.

For a considerable time past our attention has been drawn to the occurrence of a " yellows " among silver and blue foxes in some of the ranches in this country, and we have had several opportunities of examining the carcases of foxes which have died presumably from this condition. In one case only have we demonstrated the presence of leptospira in the liver of a " yellows " fox; but from our knowledge of the disease in the dog, and the satisfactory results following the use of anti-leptospira serum as a prophylactic in in-contact foxes, we are of opinion that true leptospiral infection is common in fox ranches in this country. It may be noted that it is only with difficulty that leptospira can be demonstrated in typically infected animals by microscopic examination, or even by the inoculation of susceptible animals like guinea-pigs with their tissues. (In the original research (1925) definite evidence of infection was obtained in only two of the ten infected dogs, though examination was carried out immediately after death.) We are at present investigating whether complement fixation methods will help in diagnosis.

The usual history of an outbreak of infective jaundice among foxes is that some of a group of animals refuse to eat, and on being caught and examined, the conjunctivæ and buccal mucous membranes are found to be icteric. There is much depression, the coat is staring, and diarrhœa is usually present. The stools are mucoid in character, and contain varying amounts of blood or blood clots. In some cases the motion is entirely composed of unaltered blood. Death usually takes place soon after symptoms are observed. In some cases, especially if the foxes are not under constant observation, the first affected animal is found dead, and as is the habit of foxes, the carcase is often much mutilated and partly devoured. Post-mortem examination yields characteristic lesions which may be grouped as icterus, enteritis, and lung lesions. The deep yellow pigmentation of the whole carcase is widespread, and extends to the walls of the arteries and the costal cartilages. In true infective jaundice the icterus is intense, and should not be confused with icterus of a slight degree, which we at present believe to be of common occurrence in foxes suffering from any general intestinal disturbance. A marked enteritis is generally present, and the inflammation may be confined to special areas of any part of the intestine, though generally the whole of the tract is involved. As in the dog, intussusception is common. The contents of the

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whole of the intestine may consist of mucus with varying amounts of blood, and may apparently consist entirely of blood. The lungs present the characteristic " butterfly " appearance. The surface of the lung has a yellowish appearance, and scattered over its surface are bright (sometimes dark) punctate hæmorrhages, varying in size from areas the size of a pea, and quite discrete, to irregular areas up to an inch or more in diameter. Sometimes only a few lesions are found near the thin margin of the lung, but in other cases the whole lung is involved.

Because of the susceptibility of the fox to leptospira infection, it is not surprising that " yellows " is prevalent among them, as rats, the vectors of the parasite, can only with great difficulty be excluded from the ranches. The important point in connection with prophylaxis, therefore, is the eradication of rats from the ranches, and especially from the food sheds, etc. In addition, the use of leptospira serum and vaccine may be adopted, and the results, as field evidence shows, are satisfactory. The subcutaneous injection of serum into in-contact foxes is followed as a rule by complete suppression of further cases. Unfortunately, the immunity produced by the serum is only temporary in character, and within three weeks after being treated with serum foxes are again susceptible. The use of vaccine (two doses at an interval of seven to ten days) produces active immunity, and on many ranches vaccine treatment is a routine procedure. Foxes which have been treated with serum, and which it is desired to protect further, may be injected with vaccine. A period of at least a fortnight, and preferably three weeks, should elapse between the serum and vaccine treatment. The use of large doses of serum in affected cases has been adopted, but the results are, as in dogs, variable. In the fox the disease has usually become well established before a diagnosis is made. Should it be decided to use serum in affected animals, it should be injected intravenously ; the operation can be carried out with ease if the injection be made into the external saphena vein.

" Distemper " in the Fox.

Until recently all diseases of an epidemic character affecting the fox were classified as " distemper," with the result that the description of distemper appearing in the literature may apply to almost any disease. Research work of a more definite character has shown that distemper of the fox is certainly a complex subject, and is by no means one single disease. Green (1925) investigated an outbreak of distemper, and came to the conclusion that the disease on which he worked was caused by an organism of the Salmonella group. The disease Green described bears a close resemblance to canine distemper—symptoms involving infection of the alimentary, respiratory, and central nervous systems were all present, and he showed that a great variety of organisms could be isolated, depending on the lesions present. In a few cases symptoms of an indefinite nature were present without the involvement of any special tissue, and Green considered that such cases represented the true disease. From such cases he was able to isolate the Salmonella in pure culture. He was able to transmit the typical disease to normal foxes by the injection of cultures of the Salmonella.

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Vaccine made from the organism was used in an attempt to control epidemics, and some success was claimed (1926). In one epidemic little response was obtained following vaccine treatment, and this failure led to Green's second discovery, *viz.*, that another fox disease is epidemic encephalitis (Green, *et alia*, 1928). It was shown that a disease characterised by weakness, lethargy, and convulsions was caused by an infectious agent contained in the central nervous system. It was at first thought that a streptococcus was the infective agent, but later it was shown to be a filtrable virus. Emulsions of brain and cord from infected foxes injected intracranially into normal foxes reproduced the disease. Green and Dewey (1929) compared the virus of fox encephalitis with the Laidlaw-Dunkin virus of canine distemper, and showed that ferrets are quite insusceptible to infection with the former virus, and are still susceptible to the Laidlaw-Dunkin virus after injection with the virus of fox encephalitis. They state, however, that " the virus obtained from Laidlaw and Dunkin was established in our laboratories in both ferrets and foxes, and in a later paper Green and Shillinger (1929) state that " certain symptoms of this disease (fox encephalitis) simulate those recognised in distemper in dogs very closely, but work done up to the present indicates that the two diseases are distinct." Green's work, therefore, showed that he had dealt with two diseases of the fox—a Salmonella infection, which he termed fox paratyphoid, and a virus infection which he termed epidemic encephalitis, both of which presented symptoms resembling canine distemper, but in neither of which the virus of distemper was found. Because of the close relationship of the fox and the dog, it seemed possible that the fox would be susceptible to the virus of canine distemper. Allen (Allen and McLure, 1926) seems to have had this in mind when he investigated fox " distemper," and showed that filtered blood of a fox which had just died of distemper injected into the trachea of several healthy foxes gave rise to typical symptoms of distemper, which spread from the artificially infected foxes to untreated foxes in the same ranch with heavy losses. Cunninghan (1932) refers to the work of Wickware, who showed in 1931 that the disease of foxes in Prince Edward Island in that year was caused by a filtrable virus and was communicable to the ferret, and to the work of Law, also in 1931, who regarded the disease as dog distemper. Cunningham, who studied the disease among foxes on his own ranch as well as on others, was not satisfied that it was exactly similar to dog distemper. His observations are somewhat confusing, for though he records that anti-canine distemper serum was valueless, at a later stage in his article he claims to have kept the disease, which occurred both in the fox and the fitch, under control by the liberal use of such a serum. It is also significant that fitch were affected in addition to foxes. Cunningham experimented with vaccine and serum made in foxes in a manner similar to that described by Laidlaw and Dunkin in canine distemper work. His conclusions are " that foxes can be immunised against the disease by vaccine prepared according to the method employed by Laidlaw and Dunkin for dog distemper, and that the serum prepared from recovered animals has curative properties, which suggests the possibility of

preparing a hyper-immune serum for the disease similar to that prepared for canine distemper." As far as we can trace from publications available, little research seems to have been done into fox diseases by the Department of Agriculture in Canada. Watson (1931), in his annual report, states that " little is known of the cause and nature of these infectious diseases of fur-bearing animals, and fundamental research is essential. . . . Plans are now being worked out, and it is hoped will be put into effect during the coming year."

Dr. Laidlaw and Major Dunkin kindly informed us that during the early part of this year they obtained evidence of the presence of canine distemper virus in the tissues of foxes, and we published an article showing that the silver fox was susceptible to the virus of canine distemper, and that it was possible to carry out successful immunisation with products derived from *dogs and ferrets* (Dalling, 1932). Within recent times we have carried out large-scale experiments on the same subject, the results of which are in course of preparation for publication. It may be stated, however, that the results of these large-scale experiments have fully confirmed our previous findings. That it is now accepted that the fox is susceptible to canine distemper virus may be deduced from the following statement published by the *Field* Distemper Council in its final report (1932): " True distemper has recently been found to occur among fur-bearing animals related to the dog (silver fox) and ferret (fitch, mink, fisher), and preliminary experiments already show that the methods now available will have immediate value where these animals are farmed. The work primarily undertaken for the protection of dogs seems likely, therefore, to save an important industry from losses which have hitherto been often disastrous."

As far as we know, a natural outbreak of canine distemper virus infection in the fox has not been diagnosed in this country. We have examined some twenty foxes from five ranches: careful detailed post-mortem examinations, in which the usual technique for the diagnosis of canine distemper virus infection was used, were carried out, but we have had no indication of the existence of such an infection. It is more than likely, however, that it is only a question of time before such infections will be found.

From foxes on two different ranches on which the death-rate was high, and on which foxes presented " distemper " symptoms, we have been able to isolate organisms of the Salmonella group from various tissues. It is hoped to publish an account of this work soon; but it may be stated here that from our work we have formed the opinion that epidemics may occur among foxes due to infection with organisms of the Salmonella group. It may be that such infections are introduced by rats and mice, or by the raw flesh fed to the animals, and that their occurrence is bound up with breeding and general ranch conditions. It is evident from our own experiences and experiments, as well as those of others, that so-called " distemper " in the fox is by no means a disease due to a single cause. While true distemper (canine) may occur naturally, there are other diseases which present symptoms similar to those induced by distemper virus. Further research on the whole subject of fox " distemper " is necessary.

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A SHORT REVIEW OF THE RABBIT INDUSTRY.

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OVER a century ago rabbits were bred in several parts of Great Britain in warrens for their flesh, but it was not until the Great War that the possibilities of rabbit keeping as a commercial undertaking were realised. During that period the claims of the rabbit reared in hutches to a prominent place on the dining table were appreciated, for the hutch-bred rabbit has actually a more pleasing flavour than the wild, and is comparable to the tenderest chicken. In food value it is superior to the majority of other fleshes. With our diminished food supplies it is not remarkable that rabbit breeding advanced in popularity, and many hundreds of thousands of rabbits must have been reared and consumed in this country during that period. Several large farms sprang up for the breeding of table rabbits alone, and these proved successful in many instances.

With the declaration of peace, however, our importations of foreign carcases began to increase again, and housewives demanded once more the Ostend rabbit to which they had in pre-war days been used to. This conservatism on the part of the British public is well known and inexplainable, for the Ostend rabbit is in no way superior to the British product, and the prejudice against tame rabbits reared in this country for the table still persists. It is a fact, however, that many people do not realise that the Ostend rabbit is similar in all respects to the best British product, and this is one of many points on which the National Rabbit Council is endeavouring to enlighten the public.

Soon after the conclusion of the War, certain enterprising breeders of table rabbits decided to no longer waste their pelts and sell them at a few coppers each, but to import from France and elsewhere some of the varieties which had been bred there for many years for their furs. This was the start of the rabbit fur industry. With the few breeds which were available, the British breeder set himself the task not only to improve those he imported, but also to evolve new ones. In this he has been most successful, and now there is a variety of rabbits,

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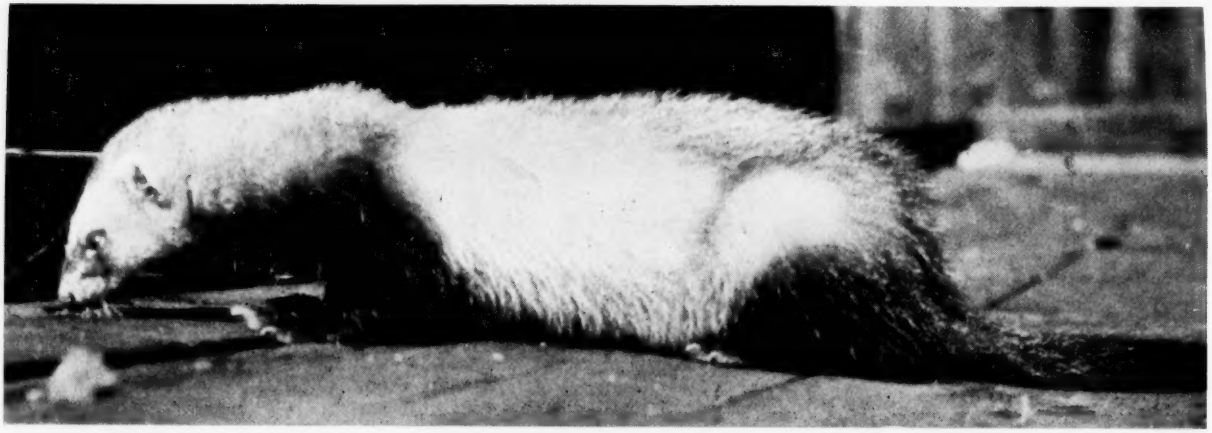

A fine example of a Fitch, owned by Mr. R. D. Simpson, Aberdeen. By the courtesy of *Fur Farming*.

The Mink. By the courtesy of Mr. Vyvian Thomas, Maidstone, and *Fur Farming*.

the fur of which closely approximates to almost all of the rarer wild fur-bearing animals. These realise fair prices at the present time, although nothing approaching the abnormally high figures realised a few years ago, and still show a fair profit with the carcase if the management of the rabbitry is undertaken on sound lines.

The youngest branch of the rabbit industry is that of Angora wool production. This industry dates back only to about 1922, and very high prices were realised for this product. A somewhat serious slump occurred in the marketing of wool during 1928 to 1929, for which the breeders themselves were largely responsible. This has, however, now been overcome, and the wool is selling to-day at from 20*s*. to 29*s*. per pound for first grades. That the rabbit industry has vast room for further expansion is clearly demonstrated by the following figures showing our imports and exports for recent years:

Angora Wool.

Imports, 1931	Cwt.	£
From France	1,330	169,810
Other foreign countries	77	6,873
British countries	13	1,230
	1,420	£177,913
Re-exports, 1931	**Cwt.**	**£**
To foreign countries	7	576
British countries	1	55
	8	631
Total imports above exports	1,412	£177,282

During the month of September, 1932, 59 cwt. of Angora wool were imported, to the value of £6,350.

Rabbit Skins (Dressed)—Imported.

Year	1926	1927	1928	1929	1930
Thousands	10,392	13,240	18,276	18,945	14,530
Value in £	843,447	1,223,662	1,709,155	1,689,927	914,396

Re-exported: About 10 per cent.

Rabbit Carcases (Fresh)—Imported.

Year	1926	1927	1928	1929	1930
Hundredweights ...	73,339	73,442	84,361	76,197	60,937
Value in £	297,149	303,125	348,398	318,295	271,263

Taking the imports for 1930, we spent well over a million pounds in rabbit products, which money could equally well have been retained in this country. The foreign producer, however, has many advantages in the way of cheap labour, and can sell his goods at a lower rate than can the British farmer, with the conse-

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quent result that a duty on rabbit products is essential for the future prosperity of the industry. This the National Rabbit Council, working in collaboration with other organisations interested in the welfare of the rabbit, is at present endeavouring to secure.

The present size and importance of the industry is hard to ascertain, but from various sources the Council estimates that there are in the neighbourhood of 75,000 keepers of rabbits in this country, of whom some 15,000 to 20,000 are actively engaged in wool production ; and in the neighbourhood of 25,000 breeding for pelts. The production of the British industry is also largely a matter of guesswork, but it is a fact that at Smithfield during 1928, 1,064 tons of British rabbits were sold, this figure being increased in 1929 to 1,162 tons. There is no record available of sales through Leadenhall Market, and many others which deal in this product. The production of pelts is even more a matter of estimate, and the figure we consider is not under 100,000 pelts per annum, probably being considerably more. There are now several firms purchasing Angora wool from British growers, and the exact production cannot be ascertained.

From this more or less general survey of the rabbit industry, it might be advisable to turn to a short review of each branch. Pelts are not now realising such high prices as was the case a few years ago. This is to a great degree due to the foreign dumping of inferior and dyed skins. The rabbit fur industry is not a rival to other British branches of the fur industry, for the market for rabbit pelts is an entirely different one to that for, say, silver fox skins. These last are solely for the wealthy, whereas rabbit furs are for the middle classes and for the man in the street. Sufficient stress is often not laid on the humane aspects of the rabbit fur, for the animal which has supplied its skin for this has been reared under comfortable conditions throughout its life, and has, in the end, had a humane despatch, as compared with the agonies often endured by wild animals trapped for their pelts. This alone is a strong point for the encouragement of British rabbit furs. Rabbits are now bred in almost every colour excepting green. Their natural undyed pelts imitate in a remarkable degree of closeness nearly all the larger wild fur-bearing animals, and an exhibition of these skins is generally of considerable interest and surprise to the public. Of the most popular varieties, may be mentioned the Chinchilla, the sables (Marten and Siamese), the Silver and Blue Fox, the Squirrel, and the Beverens, all these varieties being also found with the short plush coat of the Rex type, which many believe will be the most popular of the fur breeds in the near future. Up to the present, however, sufficient pelts have not been marketed in the Rex type to prove their utility.

Closely linked with the fur industry is carcase production, generally the two branches being combined. There are, however, a few farms still breeding for table production alone, and, we believe, finding it a profitable undertaking. In this last case large quick maturing varieties, such as the Belgian Hare or Flemish Giant, or more often still the cross between the two, are generally used. The marketing of rabbit carcases has been very faulty in the past, but the National

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Rabbit Council is taking active steps at the present time in standardising the conditions and methods of marketing by the establishment of killing centres throughout the country, to which members send their live rabbits for slaughter and marketing, the pelts being dried and returned to the member, together with the proceeds from the sale of the carcase, less a small fee.

In the Angora wool industry, the tendency has been for the spinners to pay the highest price for long, fine textured wool, which has up to recently only been produced in this country. From abroad has been imported, and still is, vast quantities of the shorter, harsher wool commonly grown in France. Whilst the fine type of wool can only be produced with considerable care on the part of the farmer, and by the single housing of rabbits, the latter type can be grown on rabbits housed in the colony system, where from ten to fifty rabbits are run together, and breeders in this country are now being urged to turn their attention to the production of this lower-valued wool. Both sides of Angora wool production show satisfactory profits to the farmer at the present time.

The last branch of the industry to which reference must be made is the exhibition side. In this the rabbit world has shown its wisdom, for practically all the standards by which the animals are judged on the show bench approximate very closely to the ideal from the industrial point of view. Shows are held throughout the country, the largest being held annually in Edinburgh and in Bradford. At these many hundreds of rabbits are exhibited each year, and winners frequently change hands at high prices for breeding. They also prove invaluable for the beginner, as by visiting these shows and by entering his stock he is able to see the faults in his rabbits and rectify them by future breeding operations.

In conclusion, a brief reference to the National Rabbit Council of Great Britain and the Dominions should be made. This organisation was instituted in 1929 in order to act as the spokesman of the rabbit world on national matters affecting the industry. It is composed of affiliated clubs and societies, both local and specialist, and private individuals are welcomed as independent members. It has already served a useful purpose in several respects, and its establishment has been fully justified. As Secretary, the present writer of this short paper is always willing to answer in so far as he is able questions relating to any aspect of the rabbit world.

NOTES ON PARASITES OF FUR ANIMALS AND CAGE BIRDS.

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In a number of The Veterinary Journal devoted to fur-bearing animals and cage birds, it is well to remind readers that these groups are often subject to the attacks of parasites both internal and external. If we embrace our calling loyally, the size of the patient should make no difference to us. The general aspects of parasitic diseases in these animals are very much the same as in our more

common patients. Diagnosis often rests on microscopical examination of fæces, or of scraping from the skin or feathers. Treatment is, unfortunately, often more difficult, but control or prevention of intestinal parasitism by means of wire-bottomed cages and hutches is sometimes easier.

In those countries where fur farming is extensively carried out, Government experimental farms have sprung up with veterinarians in control. These have published many brochures on parasitic diseases, and thus a considerable literature has come into existence. There are a number of animals which yield fur, but in this country the rabbit, fox and muskrat are perhaps the most important. Of cage birds there are hundreds of species, many of which breed freely in captivity. The coat and plumage of these two groups are the first to suffer when disease of the internal organs occurs, and there are many ectozoa which damage the fur and feathers directly. In a short note such as the present one, it is not possible to deal thoroughly with any one group of parasites or even a single aspect, such as diagnosis, treatment, or prevention. Rather is it the wish to draw attention in a general way to important parasites as they affect different hosts, and apart from the writer having encountered many of them, this article contains little original matter. The clinician will, however, be more interested in the effects of a parasite than in its name and nature, and for such the following brief clinical notes are intended.

The presence of a given parasite does not necessarily mean the existence of parasitic disease, but there may be disease, or great chances of it developing, when conditions become more favourable for parasitic multiplication, or when the host is subjected to adverse conditions, such as calcium or vitamin deficiency. It is difficult to state the relative frequency of parasitic diseases in the different species, but their presence must be expected in all groups where there is overcrowding or permanent association with fæces. Hall has coined the slogan " permanent pastures perpetuate parasites." Gross evidence of the presence of parasitic disease consists in general terms of diarrhœa, emaciation, anæmia, and deaths in the case of the ectozoa ; with the ectozoa one would expect rubbing, scratching, biting, feather picking, accumulation of scales, and loss of covering. With a history of parasitism, and a set of suspicious symptoms, the diagnosis should if possible be clinched by a microscopical examination in all cases save those where parasites can be seen. For coccidia, worm eggs, and acari, a flotation concentration is desirable, as direct smears may be misleading. If only one or two animals are affected one has to consider whether slaughter is preferable to treatment. Often it is, and many fanciers choose the clean sweep. When treatment is carried out one has the choice of tetrachlorethylene, hexylresorcinol and carbon tetrachloride for nematode infestations ; arecoline compounds, male fern derivatives, and kamala (birds) for tapeworms ; and sodium fluoride, derris root, and sulphur preparations, for external application. A formula associated with the name of Kerr is now widely used in the treatment of coccidiosis. Six ounces of a solution composed of one part of resublimed iodine with sufficient

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potassium iodide to dissolve it in fifty parts of water, is added to half a gallon of milk. This is heated until the colour of the iodine is lost, and then given to the patients to drink. Mass treatment in food is as a rule not to be recommended, although one may be greatly tempted to rely upon it. In the management of outbreaks, metallic receptacles, wire-bottomed hutches and cages, incineration of carcases, hopper feeding, protected watering, suitable warmth, improved diets of high calcium and vitamin content, together with segregation and a judicious use of approved disinfectants are the chief agencies upon which to rely. One of the most important measures to be adopted to prevent disease entering premises is that all new arrivals, or animals which have been away, should be isolated for about a month. In some cases a microscopic examination of the fæces can be used as a further safeguard.

Protozoa.—Coccidiosis is common in rabbits, especially at weaning time. Apparently it is a mixed infection of two or three species of *Eimeria*. In broad terms the presence of coccidiosis may be regarded as evidence of neglect in management. It is known that over 90 per cent. of all rabbits harbour *Eimeria*, and as we possess valuable methods of control, these should be constantly enforced as a part of the system of management. Many species of cage birds and ornamental inmates of the aviary are liable to attacks of *Eimeria*, and many different species have been described. Sudden deaths in canaries and finches may be due to *Isospora lacazei*. Vent disease of rabbits due to *Treponema cuniculi* is now known to respond quickly to the subcutaneous injection of a salt closely allied to salvarsan.

Helminths.—Worms are extremely important parasites of the fur foxes. It is estimated that about fifty species occur in them ; of these, sixteen are trematodes ; fifteen cestodes ; and nineteen nematodes. The cestodes are very similar in specificity to those of the dog. Thus one encounters *Dipylidium caninum*, *Tænia pisiformis*, *T. serialis*, and *T. echinococcus*. The fox is possibly the common cause of the spread of echinococcosis to man. The eggs of this tapeworm cannot be distinguished from those of other species of *Tænia*. Among nematodes *Toxocara canis*, *T. cati*, *Toxascaris leonina*, *Ancylostoma caninum*, and *Uncinaria stenocephala* are common factors in disease production. For these there are good methods of treatment. In the rabbit, adult tapeworms of the genus *Cittotænia* are often seen, and so are the cystic stages of *T. echinococcus*, *T. pisiformis*, and *T. serialis*. The latter often requires puncture and surgical removal. Although *Graphidium strigosum* kills large numbers of wild rabbits by attacking the gastric mucous membrane, nematodes are comparatively rare to cause loss in tame breeds. I have seen an outbreak of intestinal trichostrongylosis in chinchillas due to *Trichostrongylus retortæformis*. *Passalurus ambiguus* is quite common in the cæcum and colon. Many authors say that it is a vegetable feeder, and therefore harmless, but it often seems difficult to accept this view.

The white rat and tame mouse harbour over a dozen distinct species of cestodes each. It is common to find their intestines laden with *Hymenolepis*

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fraterna, and *H. diminuta*. The cystic stage of the cat tapeworm, *Tænia tæniæformis* in the liver often causes great enlargement of the abdomen. The nematode *Gongylonema neoplasticum* gives rise to tumours in the stomach. The bladders of most rats contain the extremely interesting miscroscopic nematode *Trichosomoides crassicauda*, the females of which carry the diminutive males in their genital tracts.

The muskrat or musquash, of which escaped individuals now threaten the countryside with invasion, has eleven trematodes, four cestodes, and three nematodes. I have examined enlarged livers containing the cysts of the cat tapeworm, *Tænia tæniæformis*, from this species. The nutria, a closely allied rodent, against whose importation there is at present an outcry, harbours many like species.

Among ornamental doves, *Ascardia columbæ* may bring about severe losses. The hair worm, *Capillaria columbæ*, also appears to cause a fatal enteritis. Some two hundred species of *Capillaria* have been described. They occur in several groups of hosts. Short of a complete revision of the genus, it is often difficult to identify the species found in different birds. It seems, however, that they often cause serious loss. They are microscopic, but several millimetres in length. The eggs are easily demonstrated in the fæces ; they are elliptical, the poles being square cut, with a " bung " in each end. Canaries may harbour great numbers of these worms. They have been prevalent this year. The grouse tapeworm, *Davainea urogalli* occurs in some of the small ground birds kept in aviaries, so does *Trichostrongylus tenuis*, a nematode closely related to the one causing " grouse disease."

Fleas.—Many mammals and birds have their own special fleas. I have taken *Ctenocephalides canis* and *C. felis* from the fox in great numbers. There seems to me little evidence that the fox really practices the wool and water trick to rid himself of ectozoa. The rabbit flea, *Spilopsyllus cuniculi* is often troublesome on the head. It is well known that the rat has several species, and that one of them is *Xenopsylla cheopis*, the transmitter of plague to man. *Ceratophyllus sciurorum* occurs on the squirrel, *C. columbæ* is found on doves, and *C. fringillæ* on sparrows and finches.

Lice.—Blood-sucking lice are common on most mammals. Many also have biting lice, but the number of species of the latter attacking birds is legion ; in fact it has more than once been proposed that the lice of certain groups of birds should be made use of in settling relationships.

Hæmodipsus ventricosus is sometimes found on young rabbits. I have seen serious losses from acute anæmia in white rats, due to *Polyplax spinulosa*, and there are many records of experimental work being disorganised by deaths of mice harbouring *P. serrata*.

Acari.—Several of the fur-bearing animals are liable to the attacks of mange mites. Such diseases are often very difficult to treat and control. It is by no means easy in many cases to explain how the disease gained access to the premises.

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Canker of the ear of the rabbit is due to *Psoroptes cuniculi*. *Chorioptes cuniculi* and *Notoedres cuniculi* commonly cause mange of the body, and occasionally other forms are seen. In the depths of the coat two acari, *Cheylitiella parasitivorax* and *Listrophorus gibbus*, which appear to cause very little damage, are often seen. In rats and mice *Notoedres muris* causes " warty ears " and scaly tail. Foot rot in ferrets and polecats is due to a sarcopt. The red mite, *Dermanyssus avium*, is extremely troublesome to many species of cage birds at nesting time. It is nocturnal and temporary in habit, and is thus comparatively easy to control, often, however, at the expense of all breeding operations. Species of a *Dermoglyphus* cause considerable irritation to budgerigars at moulting.

Apart from the genuinely parasitic mites, there is a number of free-living ones which are found in bedding materials and farinaceous foods, and which at times cause irritation of the skin, alimentary canal, and natural orifices of birds and mammals. Thus they are blamed for " eczema," canker of the ears, vertigo (ears), diarrhœa, and vent disease. Among those associated with these conditions may be mentioned the so-called cheese mites, *viz.*, *Tyroglyphus longior*, *T. siro*, and *Aleurobius farinæ*.

This brief and disjointed survey shows that most of the groups of parasites which are encountered in or on our usual patients also affect the smaller mammals and birds. Although no consideration has been given to the parasites of ringworm and favus, this statement applies equally to them. An extension of the principles of diagnosis, treatment and control in daily use to these species should be of benefit to the animals themselves and their owners.

OUTLINE OF A FEW DISEASES WHICH OCCUR IN SILVER FOXES BRED IN THE BRITISH ISLES.

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THE silver black fox, commonly known simply as the silver fox, is the most valuable of all the animals bred under domestic conditions for their fur. At one time the pelts fetched very high prices, and in consequence the animals could only be obtained at exorbitant prices. Now, however, the values are much lower, both of pelts and live animals, but if the business is run on economic lines, and the breeding stock is composed of good quality animals, it yields a very good return on the money invested in it. These animals, although they have been bred in captivity for a number of years, are still semi-wild. They have to be caught by placing a pair of tongs around the neck, holding the tongs in position with one hand and catching hold of the hind legs and tail with the other hand. An assistant then ties a muzzle round the mouth with a piece of tape in the same manner as a dog is muzzled. The handler can receive a very nasty bite if he

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does not have a secure hold of his fox. An interesting point is that sometimes fox cubs are reared by cats, or even by hand, and owing to the handling they receive, they become as tame as dogs. They remain tame even when adult, and penned with their wilder brethren.

Owing to the custom of keeping foxes in rather isolated localities, and also owing to the hardiness of the adult animal, comparatively little disease has occurred among them, although the incidence has certainly been greater with the increase in the number of fox farms in the country. There is, however, an enormous mortality among the cubs. Silver foxes have only been bred under domestic conditions for a short time, and have been kept in large numbers only within the last decade or so ; consequently the same difficulties are experienced among them as among other wild animals bred in captivity. Chief among these difficulties is the failure to breed, and also irregular breeding, *i.e.*, producing progeny one season, and missing the next.

Foxes are usually kept in pairs, the two animals occupying the same pen all through the breeding season, and sometimes all through the year. Very often a vixen is bred to the same male all her breeding years if the progeny are satisfactory. The œstral period occurs in January, February or March, most of the cubs being born in April. The period of gestation is fifty-one to fifty-three days. After the birth of the cubs it is not unusual for some of the vixens to bring their cubs out of the kennels and bury them in the ground or leave them lying out in the cold. In this way a considerable number of cubs are lost, but most of the deaths appear to be the result of round-worm infestation. As foxes are kept in the same pens all the year round, it is rather difficult to clear a farm of ascarides and eggs once these have become established. Most farms are equipped with blow-lamps, some being very elaborate affairs, and most fox farmers arrange for some of the pens to remain unoccupied for several months of each year ; but as many of the adult foxes harbour a few worms, these preventive methods are insufficient. Also, the industry being of Canadian origin, many farmers rely on worm remedies that are advertised and used in that country, most of which do not prove effective. This may account to some extent for worm infestation being so general. It is also the custom on many farms to dose the cubs at the tender age of three weeks, and it is obvious that dosage must be very accurate at that age to avoid disaster. Owners who have succeeded in eradicating worms from the foxes and eggs from the pens, find that re-infestation is rare, and dosing of the cubs unnecessary. The species appear similar to those found in dogs. Those mentioned in the Canadian Government Bulletins are *Belascaris marginata*, *Toxascaris limbata* and *Belascaris cati*. Canadian literature on this subject also alludes to lung worms and hook worms, which do not appear to affect British foxes at present to any extent. Tape worms are not common in foxes, or perhaps, doing little damage, are not noticed. Certainly raw rabbit forms a large part of the diet of foxes, and this is likely to prove a source of infestation.

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A Champion Beveren Rabbit, the property of Mr. D. K. Marwick, Farnham.
By the courtesy of *Fur Farming*.

Glandalen Lewis If, a polygamous male Silver Fox, owned by Mr. H. W. MacKendrick, Blairs, Aberdeen.
By the courtesy of *Fur Farming*.

A grand Vizor Pigeon.
By the courtesy of *Feathered World*.

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The young animals also suffer from deficiency diseases where the feeding is at fault, the commonest condition being rickets. The symptoms are similar to those in the dog, the most noticeable being the bent legs. Fleas are fairly commonly found on foxes, and if left unmolested, do considerable damage to the fur. Skin diseases are uncommon except for ear mange, known as " ear-mite " among fox farmers, and a peculiar irritation of the end of the tail which causes the fox to bite off the complete tip. This is treated by the fox farmer quite successfully, if the condition is caught early, by painting with tincture of iodine, but the damage is usually done before the disease is noticed.

Distemper has only been reported on one British fox farm, and there is very little information concerning this outbreak. Owing to the great distances between the fox farms, infectious disease does not spread very readily. The only time that foxes from various farms are congregated in one place is at the annual show of the Silver Fox Breeders Association of Great Britain and Ireland. Most of the foxes are quarantined on returning to the farms. According to the Canadian reports, distemper runs a similar course in foxes as in dogs, but as the foxes are in pens, and not handled nearly as much as a pet dog, the disease is always at a more advanced stage in the fox before it is observed. The mortality is reported as being high, but even in Canada the disease is uncommon. Many farmers in this country have had their foxes inoculated against distemper, and canine serum is used.

Malignant jaundice has occurred on several farms. The disease is contracted from rats, which get into the pens and are killed and eaten by the foxes. The disease usually responds to serum treatment, though losses occur.

A disease which has caused considerable loss on some fox farms is characterised by a species of epilepsy, followed by rapid death. The animals appear to be in normal health almost up to the time of the fit, and die soon afterwards, some dying during the attack. It does not appear to occur in all adults, but is very severe among the cubs. In Canada there is a disease known as contagious or infectious meningitis, the symptoms of which seem to tally with those of the disease mentioned, but the only information which the writer has about this ailment has been obtained in conversation with the fox farmers. Usually when any disease occurs on a fox farm the animal is destroyed, or doctored by the farmer himself till the animal is in good enough coat to be pelted, and in this way much accurate detail of the conditions which occur in foxes does not become known to the veterinarian ; but even now the farmers are feeling that they wish to know more about the prevention and cure of the conditions which they meet among their foxes.

Up to the end of 1931 there had been 3,245 foxes registered in the stud book of the Association, and there will be close on a thousand this year, so that the numbers are increasing appreciably, and there is a considerable field awaiting to be investigated among these valuable animals.

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INFECTIOUS MYXOMATOSIS OF RABBITS.

By G. M. FINDLAY.

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INFECTIOUS myxomatosis of rabbits is a virus disease of considerable interest, since in certain ways it resembles the infectious fowl tumours. The condition was first described by Sanarelli (1898) as the result of an epidemic which broke out among domestic rabbits in the animal house of the Institute of Hygiene in Monte Video. Since then other outbreaks have been reported in the Argentine, Brazil and Uruguay; more recently rabbitries in Southern California have become infected (Kessel, Prouty and Meyer, 1931). The disease is thus restricted to the New World, and appears to be almost specific for the domestic rabbit, a point of some interest as regards the origin of the condition, since there are no true rabbits in South America (Scott, 1924), the European domestic rabbit not having been introduced till the Spanish conquest, and never having become wild as in Australia. According to Moses (1911), the hare of South America (*Lepus brasiliensis*) can only be infected with difficulty, while the jack rabbit (*Lepus melanotis*) of North America is entirely insusceptible. Findlay (1929) succeeded in infecting a Belgian hare. Other animals, including monkeys, both Old and New World, dogs, cats, rats, mice, hamsters, pigeons, fowls, and even guinea-pigs, are insusceptible. Whether any other South American rodents are susceptible has not yet been determined.

Clinical Symptoms.

The disease is extremely contagious, and healthy rabbits placed in the same room as infected animals almost invariably become sick. Epizootics may kill 100 per cent. of a stock (Aragao, 1927), or may after some time gradually subside (Splendore, 1909). After repeated passage the virulence of the virus becomes exalted, though certain strains of rabbit are more resistant than others, and show fewer metastatic deposits. In the naturally occurring disease the earliest symptom is a muco-purulent discharge from the nose and conjunctivæ, quickly followed by swellings at the root of the ears, in the eyelids, around the mouth and anus, and in the tissues of the scrotum and prepuce. In the female, the orifice of the vagina is swollen. The incubation period of the naturally occurring disease is from four to seven days, death, which is almost invariable, taking place seven to twelve days later. Some days before death there is loss of appetite and great emaciation. A secondary bacterial infection, almost invariably due to *Pasteurella lepiseptica*, is very common, and may account for the leucocytosis recorded by Hobbs (1928). In some animals there are no symptoms except conjunctivitis and emaciation. Experimentally the disease can be produced by subcutaneous, intra-peritoneal, or intravenous inoculation. Following intravenous inoculation swellings appear after an interval of from seven to ten days in the eyelids and in the scrotum. Moses (1911) and Findlay (1929) found that when injected intravenously, the virus can be localised in any area of skin merely by plucking out the hairs or by

pricking histamine into the skin. Application of virus-containing material to the scarified skin or instillation into the conjunctival sac or nares also results in infection. The nares most probably represent the portal of entry under natural conditions.

Pathological Changes.

At death, round or oval tumour-like masses are found scattered throughout the subcutaneous tissues, more especially in the region of the various orifices of the body. They are firm to the touch, and sometimes feel almost cartilaginous, though, especially round the genitalia, they soon become œdematous or even vesiculated. If the animals survive long enough, according to Rivers (1930), the vesicles are replaced by crusts which cap the tumour nodules. On sectioning the tumour-like masses, they appear pink or even purplish in colour and slimy to the touch, while they possess a curious characteristic odour not unlike that of carrion. They may be attached to the underlying muscles. Secondary metastatic deposits occur in various organs, though the extent of the deposits varies both with the strain of rabbit and with the physiological condition of the particular animal. Thus enlargement of the lymph glands and spleen is common in rabbits in America, but was not encountered in an in-bred strain of English rabbit (Findlay, 1929). Interstitial epididymitis and, less commonly, orchitis were, however, present. As a rule the kidneys, pancreas, thymus, liver, stomach, intestine, adrenals and ovary are not affected. In the lungs, myxomatous nodules are occasionally observed in the vicinity of blood vessels and bronchi. Sprunt (1932) has found that pregnancy may alter the reactivity of the tissues to the virus, since the livers of pregnant animals with myxoma have a central acidophilic necrosis of the lobules. Secondary lesions in the lungs are much more numerous and larger in the pregnant than in the non-gravid animals, as are also the lesions in the spleen. The skin changes on the other hand are less marked in pregnant rabbits.

Histologically in the skin both the epidermis and the cutis vera may be involved. In the cutis vera the chief feature is the enormous dilatation of the connective tissue spaces filled with a mucinous deposit which Lipschütz (1927) believes to be derived from a mucoid degeneration of the collagen. This mucinous degeneration also involves the subcutaneous tissues. Scattered throughout the swollen tissues are greatly hypertrophied spindle and stellate cells, often with numerous chromatin granules in the nuclei (Aragao, 1911 ; Findlay, 1929), and frequently hypertrophied nucleoli. In the cytoplasm there is a myxomatous material which, as described by Hobbs (1928), is acidophilic in character. Hyde and Gardner (1930) suggest that these cells correspond to the malignant cells of mammalian tumours. Apart from the stellate cells, there are also large flattened cells of an epithelioid type, which Lewis and Gardner (1932) believe to belong to the group of hypertrophied and transformed mononuclear leucocytes. In the earliest tumours up to forty-eight hours after inoculation, neither the spindle cells nor the macrophages are markedly hypertrophied, although many of the nuclei of the spindle cells are granular. As the tumour increases in size the number

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of stellate cells also increases, though mitotic figures are not common, except occasionally in the neighbourhood of the hair follicles. Many of the stellate cells contain the phagocyted remains of other cells. The myxomatous masses are very vascular, with dilated capillaries and swollen capillary endothelium. Here and there the blood vessels are surrounded by large polygonal cells, while there may be small scattered extravasations of blood. In certain areas, possibly as a result of secondary infection, the swollen tissues contain large numbers of polymorphonuclear leucocytes and occasional eosinophils. In sections of the swellings stained with osmic acid fatty globules are seen, partly extra-cellular, partly within the enlarged stellate cells. The changes in the epidermal cells were first described by Rivers (1926). The earliest change is an increase in the number and size of the cells; then small acidophilic granules appear in the cytoplasm. These rapidly increase in number and eventually replace the major portion of the normal cytoplasm. Among the acidophilic granules round or rod-shaped blue bodies, probably nucleolar extrusions, may be seen. The nuclei become swollen or vacuolated and the chromatin fragmented. Finally the cells undergo dissolution and vesicles appear in the epidermis. Rivers (1930) also described the appearance of similar changes in the epithelial cells of the bronchi, and in one rabbit in the epithelial cells lining different parts of the epididymis. Hobbs (1928), Sprunt (1932) and others in America, have confirmed the occurrence of these changes in the epidermal cells. Findlay (1929), in English rabbits, failed to detect any definite epidermal changes, except when secondary infection occurred, and polymorphonuclear leucocytes infiltrated the cells. Then the whole epidermis might slough. Nucleolar extrusions were found as in any normal epithelium, while occasionally some of the cells of the basal layer had a ballooned appearance. The changes in the enlarged lymph glands and spleen have been studied, especially by Rivers (1930) and Stewart (1931). A definite degree of hypertrophy is the first change noted, the increase in size being at times tenfold. Discrete red areas then make their appearance on the surface of the glands, which eventually become hæmorrhagic throughout, and firm to the touch. At first there appears to be some increase in the lymphocytes, then cells, often multinucleated, make their appearance in the lymph sinuses at the periphery of the gland. These cells, which resemble the myxomatous cells of the subcutaneous nodules and are derived from the splenic reticulum, at first exhibit numerous mitoses, but with the disappearance of the lymphocytes which then ensues, and the appearance of myxomatous degeneration, there is a marked slowing down of the process, and evidence of mitotic activity is rarely seen. Polymorphonuclear leucocytes may be numerous. Similar changes, though on a lesser scale, are found in the spleen. In the epididymis and testicles the myxomatous changes are associated with degenerative changes in the tubular epithelium. While the earliest changes thus resemble those seen in neoplastic growths, the proliferative wave is followed by a more or less indolent stage, which serves to differentiate the condition from a true malignant condition.

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Inclusion Bodies.

While the changes described by Rivers (1926) in the epidermal cells are most probably of a degenerative character, considerable discussion has arisen as to the true nature of the granules which are present in certain of the mesodermal cells found in the myxomatous nodules. A large variety of intracellular inclusions in these cells have been ascribed to the presence of the virus. Splendore (1909) in Giemsa-stained smears described trachoma-like bodies in the connective tissue cells and occasionally in the polymorphonuclear leucocytes. These bodies are almost certainly phagocyted nuclear debris. Aragao (1911) found in the nuclei of the hypertrophied connective tissue cells a rarefication of the chromatin, together with small round chromatin masses which at the time he described as organisms under the name of *Chlamydozoon myxomæ*. More recently Aragao (1927) has described certain fine granules, about 0.1μ in diameter, as possibly representing the virus. These rounded bodies, which he terms *Strongyloplasma myxomæ*, may be demonstrated by staining either with Loeffler or Giemsa, after making very fine smears from fresh tumours, or by filtering infective material through a film of agar, which is subsequently removed by washing. Lipschütz (1927) described in the cytoplasm of the connective tissue cells small bodies, either alone or in little masses, varying in size from a just visible granule to a large coccus. Larger forms, diplococcal or even angular in shape, were also described. The granules were present not only in the myxoma cells, but also in the endothelial cells lining the lymph spaces, and in the much swollen connective tissue cells of the deeper layers of the skin. Lipschütz gave these granules the name of *Sanarellia cuniculi*.

More recently Findlay (1929) and Ludford (1930) have described and figured somewhat similar granules in connective tissue cells of the myxomatous lesions, either collected into small masses or spreading out into the cytoplasm of the cells. Lewis and Gardner (1932) have also found that the epithelioid type of cell contains within its cytoplasm numerous small granules which stain a pinkish-purple with Wright's stain. The granules in the various cells are of different shapes and sizes, though those present in one cell are of approximately the same size. They vary from small round granules and short rods to more or less triangular-shaped granules. They are massed round the centrosome at one side of the nucleus, from which point they scatter out to fill more or less the whole cytoplasm of the cell. In many ways the granules are strikingly similar to the bodies described by Cowdry (1925) in heart-water as *Rickettsia ruminatum*. The cells which contained the granules in largest numbers belong to the group of hypertrophied transformed mononuclear leucocyte, although similar granules in lesser numbers are seen in typical monocytes and in the greatly hypertrophied stellate cells. It is suggested that the granules are possibly formed from accumulated protein arising from the infiltration of the tumour with myxomatous material, since a very similar appearance is seen in the cells of chick embryos cultivated *in vitro* in a medium rich in egg-white or albumin. Further research is obviously required to determine the true nature of these granules.

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Properties of the Virus.

The virus of infectious myxomatosis possesses considerable resistance to glycerine, and may survive for not less than two years. When dried in a desiccator and kept at room temperature it retains its virulence for at least a month. Even at 37° C. it remains alive for six days in physiological saline, a fluid which inactivates many viruses. It is readily killed by heat—50° C. for fifteen minutes (Hobbs) ; 50° C. for one hour, or 60° C. for thirty minutes (Moses). It survives in a range of pH from four to twelve for fifteen minutes, but is inactivated outside those limits. It can also be destroyed by exposure to ultra-violet light (Hobbs, 1928). Natarajan and Hyde (1930) find that it is electro-negative at from pH 4.9 to 9.3. Moses (1911), Hobbs (1928) and Findlay (1929) all succeeded in filtering the virus with a considerable loss of potency, probably due to the ease with which it is adsorbed by the filter candles. Lewis (1931) has recently found that it is possible to obtain protein-free suspensions of the virus by shaking extracts of the tumours with 25 per cent. of animal charcoal, or with aluminium hydroxide. Lewis and Lewis (1932) find that the virus is inactivated by toluidin blue, phenol, indophenol and phenol-3-indophenol. Sanarelli (1898) and Moses (1911) also describe the effects of a number of antiseptics on the virus.

A suspension of myxoma material diluted 1 in 1,000,000 still contains active virus, while blood, nasal secretion and tissue emulsions are all infective. Blood contains the virus even during the incubation period. Haagen (1931) has recently succeeded in cultivating the virus for as many as thirty passages in tissue culture, fresh rabbit testicle being used as the medium. Benjamin and Rivers (1931) also obtained a regeneration of the virus in the presence of exudate cells surviving *in vitro*. Barron (1932) investigated the metabolism of the myxomatous nodules. While their respiratory rate is low there is definite aerobic and anaerobic glycolysis with a Pasteur reaction of +1.5, similar to that of benign tumours.

Little work has been done on immunity in infectious myxomatosis, since the recovery rate is so very low. No protective, curative or viricidal antibodies have been found in the serum of inoculated animals, even in the case of two of Sanarelli's rabbits which survived infection. Fisk and Kessel (1931), however, have recently obtained two recoveries in rabbits infected with the California strain of infectious myxomatosis, which is rather less virulent than the South American strain. These rabbits were immune to subsequent inoculation with both strains, as were rabbits immunised with phenolized or formalinised vaccines.

Infectious Fibromatosis.

Very recently Shope (1932) has described in America an infective condition of rabbits which apparently bears some relationship to infectious myxomatosis. From subcutaneous tumours of a wild cotton-tail rabbit (*Sylvilagus sylvaticus*) there has been secured an agent which when injected subcutaneously and intratesticularly into the domestic rabbit or the cotton-tail rabbit, produces at the site of inoculation a large firm tumour-like mass composed of rapidly growing

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connective tissue. This mass reaches its maximum size in from ten to thirty days in the domestic rabbit, and then slowly regresses. It persists much longer in the wild cotton-tail rabbit. There are no metastases, no systemic disturbances, and no fatalities. The disease is transmissible in series. One infection renders a rabbit immune, and serum from such an immune animal neutralises the ætiological agent which passes both V and N Berkefeld filters, and resists glycerination in the ice chest for at least eighty-six days. The virus is not demonstrable in the blood stream and intravenous and intraperitoneal injection into rabbits is without effect. White rats, mice, guinea-pigs, and chickens are insusceptible. Sections of the skin overlying the tumours in the original animal showed lesions of the epidermis strikingly similar to those described by Rivers (1926) in infectious myxomatosis. Similar lesions were not observed in inoculated animals, a point of interest in view of the failure of some rabbits to develop the epidermal lesions in myxomatosis. Although the clinical and pathological pictures are very different, and although serum from a rabbit in which the tumour has regressed fails to neutralise the virus of infectious myxoma, nevertheless a rabbit convalescent from infectious fibromatosis is resistant to infection with the virus of infectious myxomatosis.

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THE VALUE OF VETERINARY SCIENCE TO THE PIGEON FANCIER.

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If, when in 1874 I enrolled as a student at the Royal Veterinary College, I had suggested that there should be a "chair" dealing with poultry and pigeons, etc., the idea would have been ridiculed, and when in my early association with the Midland Veterinary Medical Association I suggested members might consider poultry breeders as clients, the idea was dismissed without a moment's consideration. To-day there are breeders whose poultry food bill is greater than that for a herd of Jerseys. There are pigeon fanciers who sell pigeons at prices higher than a cow realises. Two hundred pounds was paid for a celebrated "Owl Cock." One hundred pounds has been paid several times for special Carriers, Pouters, and Dragoon Pigeons. A well-known Oriental cock was sold for £50. Homers, Tumblers, Fantails of quality have been sold for £20 each, as have some of my "Vizors." For my best Vizors a very large sum would be required to induce me to sell. Five pounds is quite a common figure for pigeons of all varieties. As it may prove a useful addition to the income of some practitioners, students should give special attention to this side of the curriculum.

In establishing a pigeon aviary, avoid introduction of disease with original stock. It is desirable as far as possible (it is usually difficult in purchasing from many dealers) to have knowledge of the lofts from which the birds emanate. Although adult birds of advanced years may be healthy and breeders, it is as well to start with young birds as a foundation. In selecting a site for a loft, particularly for birds not to be liberated, the building front should, as nearly as possible, face south, to have a floodlight of sun and a good supply of fresh air. It is most important not to overcrowd. Six pairs of pigeons with reasonably free air space and suitable breeding boxes will produce and rear more young than twelve pairs in crowded pens. Not only is limited air space harmful, but birds crowded, fight, encroach on each other's nest boxes, disturb the sitters, break eggs, and in other ways cause confusion. Details of construction of lofts must have regard to the variety of pigeon. It must be remembered, contrary to popular belief, that what some term "delicate varieties," such as Oriental Frills, etc., do not require coddling, they are hardy, and stand a fair amount of exposure.

At my start nearly thirty years ago with these "Gems from the East," I had my loft doors constructed like stable doors—in two halves, also fitted with movable wired frames for the upper space to enclose the birds if necessary. I found in practice, doors were unnecessary, and the breeding lofts are now open the year round. Occasionally, with continuous driving rain, the lower half may be closed to prevent flooding the wooden floor. If avoidance of cold north and east winds is desirable for the aviary, it is still more essential for nest or breeding boxes. More young squeakers have died from exposure to cold than from disease,

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particularly during severe weather, when the parents at times do not cover them closely, or when the cock is driving the hen, to commence a fresh nest. In such cases of cold the young squab may be placed in a basket near a fire, kept warm for a time, then returned to the nest. Or taking the hen from the loft will send the cock to the nest until the hen is returned to her duty later in the day. Clean drinking water protected from fouling is essential, also a supply for baths (of which the pigeons are particularly fond), to be changed as soon as soiled to prevent drinking. Pigeons quickly plunge into fresh water, and leave much scum (dirt) floating on the top. Loft floors should have a space underneath which gives circulation of air, keeping the floor dry and sound. The cavity, 3½ in. to 5 in. deep, facing the yard or flight, can be enclosed by boards or perforated iron plates. The cavity in the rear can be left exposed or closed as desired. The floor of the wired-in flight facing the breeding loft is better concreted or paved, on which ashes or sand may be spread. The frequency or otherwise with which pigeon houses may be sprayed, or the perches creosoted, should be considered in building lofts. A reasonably free access for a man to do the work should be provided for.

For fancy pigeons more elaborate structures are required than for pigeons allowed liberty outside the aviary. My main loft for "Vizor" breeding is constructed of tongued matchboards, the walls being hollow with gable roof of boards covered with galvanised sheets which are lined with thin boards. A wood partition along the centre divides the building in half. The one facing south is again subdivided into three sections, with suitable nest boxes in each for nine pairs, perches and ample sleeping room or shelter from bad weather. Each section opens on to a paved yard or flight, which is essential for exercise, enclosed on all sides and above with sparrow-proof wire netting. Sparrows are great robbers of corn, also may convey disease, so should be kept out. Mice and rats must be guarded against. An iron-framed wire-netted door leads into the first loft and yard, and similar doors to the others. The other half of the main wooden building is for storing corn-bins, nest-pans, sawdust, etc., baskets, isolation and pairing cages, and also, when necessary, acts as a hospital. There is gas, sink, hot and cold water, cleaning tools, and in fact everything suitable for hygienic breeding. There are auxiliary pens, including one consisting of a combined series of single pens, each opening on to a common enclosed flight. Shelves and ledges should be fixed at suitable intervals. For perches, nest boxes or baskets, Fantails require special consideration to protect their tails; Pouters to allow of their pouting; Trumpeters to preserve their enormous foot feathers, and so on.

For disinfecting use, "Thretipene" carbolic fluid, or "Thretipene" pine oil fluid. For birds at liberty, Homers and the like, no space beyond that contained in the loft is required, although some breeders have very elaborate houses. Provision is made for entry and exit, and protection from cats. Where it can be done with safety, a wall nest box, or on top of a pole, creates a natural home and breeding place. Corn thrown on the ground should not be more than actually

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needed for a meal, to avoid soiling by droppings, which may cause coccidiosis, etc. During the breeding season one is tempted to leave more corn than necessary, lest the young do not get sufficient from the parents. That may be dealt with by making a later visit and judiciously throwing down a small additional feed.

Pairing is allowed about the middle of February to the end of March, except in places such as farm yards, etc., where birds fly at liberty all the year round. It is usual to separate the sexes at end of the breeding season. Three or four nests are sufficient in one year. After dividing about the middle of August, the cocks should be kept as far as possible from the hens. Close contiguity to hen, or over-feeding, may start hens laying before pairing. In such instances, particularly if two hens pair up, as is quite common, let them sit the eggs, which will prevent them laying again too quickly. Some pigeons will lay and sit six or more sets of eggs, but this wears out a hen. Late hatched October-November birds are seldom reared satisfactorily, dying from cold or neglect by parents or feeders. A local breeder has tried rearing late October-November hatched birds this season—*every late bird died.*

Early in the season, before pairing, and when arranging on paper the birds respectively contemplated for pairing, take stock of pens, lofts, breeding boxes, drains, etc. Carry out all necessary repairs ; stop roof or gutter leakages ; see that perches are firmly fixed ; paint and limewash, using " Thretipene " disinfectant in the wash ; and if suspicious of parasites, give perches and roosting places a coating of creosote. Mites particularly work their way into cracks, crevices, or soft timber. Habits of different varieties have to be considered as to space, and their roosting or perching accommodation. Both parents take turns on the nest during incubation and afterwards, also in feeding their young. During this stage many young are lost, sometimes owing to parental neglect, through cold, and in some instances from disease transmitted by one or other of the parents. The young seem cheerful and well-fed overnight, and found cold and dead with crop full of food next morning.

Occasionally, before the youngster is many days old, the male commences driving the hen to nest. It is better that each pair should have a double breeding or nest box, so that when the cock starts driving, the hen may go to the alternative nest, and avoid trampling on the young in the other nest. It also reduces the risk of the cock bird savaging the young, which sometimes happens.

Pigeons of clean-cut symmetry, without food featherings, can be more easily accommodated with perches and nest boxes than heavier or clumsier varieties. Oriental Frills, African Owls, and short-beaked varieties, or with profuse head feathers, such as Jacobins and Trumpeters, are not usually good parents, being unable to pass the food into the young. It is therefore well to keep a supply of foster parent pigeons, such as Homers, Magpies, Tumblers, etc. Both sets of birds should have laid about the same date, although if foster parents are one or two days later the young squabs may be kept with their own parents for this time, and derive extra benefit from the additional soft food when transferred. Baskets

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or boxes should be carefully inspected. They may readily convey disease, particularly parasitic, mites, etc. They should be well ventilated, and except boxes that are used to send out Homers for flying competitions and the like should be partitioned in single compartments ; and for show purposes no other baskets should be used. A supply of cut straw or suitable litter should be at the bottom of each partition. This should be destroyed after use, and the baskets kept clean. As the empty baskets are stored in bulk at shows, it is possible for parasites to be collected and brought back with the birds. A little corn is sometimes put on the litter in the basket for shy feeders at shows, or heavy feather-faced birds such as Trumpeters, Carriers, and Barbs. Keep a watchful eye at shows to see there is a liberal supply of drinking water. Do not send birds to many shows, or during breeding seasons, unless this can be done without interfering with breeding, and avoid shows were pigeons are kept from home for five or six days.

SOME COMMON AILMENTS OF THE PIGEON.

By THE EDITOR OF "THE RACING PIGEON."

GENERALLY speaking, the long-distance racing pigeon fancier, whose birds may be called upon to fly home any distance from 80 to 700 miles, will not be much concerned with curative measures, as his opinion will be generally that a bird that has been afflicted with some serious malady will be unlikely to retain the necessary stamina for the long hard tasks imposed upon it. The habit is generally therefore to destroy any bird that has had any serious illness. Racing pigeon fanciers will, however, generally be intensely interested in preventive measures.

Many of the diseases with which racing pigeons are afflicted are contagious, and disease may easily be introduced into a loft through birds that have been basketed for a race with others that act as carriers, or are actually suffering from a disease in an incipient stage. Among the diseases that have particularly been found to afflict all the inmates of a loft are the following :

Canker.—This disease is one of the worst, if not the very worst, and most common amongst all classes of pigeons. The secretions of the mouth are dried up or thickened. A whitish deposit may be seen on the membrane in patches, and if the disease is not checked, dry ulcers of a yellowish or dirty-brown colour are formed. In some cases large cheesy masses are formed in mouth and throat and on the eyelids and wattles.

One-Eyed Cold.—A very troublesome complaint when it makes its appearance in a loft. The first symptoms are a blinking of the eyelid, which the bird has a difficulty in keeping open. Then follows a watery discharge, and upon pressing back the lid, red streaks will be seen underneath, and the disease sometimes affects the whole of the inmates of a loft.

Roup.—The head of the pigeon is hot and feverish, and its mouth, and in some cases its nostrils, are full of sticky matter.

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Pock.—This disease is little known in this country, but is very common in Belgian lofts. The symptoms are a breaking-out on the eyes and beak, a sort of avian diphtheria. Nearly every noted fancier in Belgium has his birds treated with preventive vaccine against this complaint.

There are a number of other minor diseases, such as diarrhœa, wing disease or "lumps," feather rot, "going light," which ought to be investigated and for which preventive measures might be advised; but those that most seriously affect racing pigeons, and for which the fancier will be most interested in finding preventive measures, have been enumerated.

HYGIENE AND THE CAUSE OF AVIAN MALADIES.

By HENRY GRAY, M.R.C.V.S.

Earl's Court, London, W.

Most species of bird in a state of nature live under the best hygienic conditions. They breathe the purest of air, mainly live on living food, and rarely eat off soil fouled by their own fæces. Again, they adapt themselves to suitable surroundings, and migrate more or less extensively according to climate, season, or in search of food.

In confinement, especially on the intensive system, all this is changed, and birds have no instinctive choice as to food, exercise, or changing their surroundings. The creatures have to put up with what is forced upon them. Often overcrowded, they are constantly soiling the ground surface, the perches and their food and water with fæcal matter. They are liable to fight among themselves, and often do damage to one another. The sleeping accommodation is generally badly insulated either for the summer or winter climatic or meteorological conditions. Disease is often introduced by fresh birds acquired from infective shops or unscrupulous fanciers. Quarantine is rarely adopted to lessen the risk. In some districts, especially during certain meteorological conditions, and in retentive clayey soils, disease is more rampant than on chalky, gravelly or sandy soils. It prevails more in wet or changeable chilly weather than when the season is hot or dry, and a cold, low temperature. Still, a sudden spell of cold is followed by numerous sudden deaths, mainly among foreign birds from tropical countries. Foods or plants gathered in wet seasons are more liable to disease, which alters their chemical or nutritional value, and these react on the birds consuming them. The diseases of plants that are mostly injurious are those caused by moulds or fungi, which are in many instances poisonous. Again, in certain seasons plants, although themselves free of disease, often contain toxic principles, and when consumed in a great quantity with other foods create toxic effects. The bad storing of foods, especially grain and seed, often gives rise to the development on them of fungi or moulds, and these, when ingested, set up disease either from the growth of such moulds on or in the living tissues, or by their poisonous properties on the whole system. Foods of animal origin often undergo changes by the presence of

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putrefactive micro-organisms or of moulds. Such foods are hard-boiled egg, egg flake, meat meal, fish meal, ground locust insects, silk-worm pupæ, other insects and their products. Eggs derived from hens carrying germs such as *Salmonella pullorum*, *Bacillus ærtryke*, or *Mycobacterium tuberculosis*, or affected with disease, are likely to transmit disease to birds fed on such. Many of the toxic or injurious properties of contaminated food products are, however, destroyed by roasting or boiling. An ill-balanced ration, as too much carbohydrate to protein or calcium to phosphorus, is liable to set up disease, especially in the young or immature. An excessive quantity of oily material or of one vitamin over the other is particularly injurious. A variety of living food, such as seeds, green vegetable matter, insects, worms, or freshly killed meat, given together, is not conducive to disease, because the instinct of the animal leads to it selecting such as are beneficial to its well-being.

Birds being fatigued in avoiding being caught up in aviaries, forced change of surroundings, or being turned out into an outdoor aviary during inclement or cold weather after being kept indoors, often suddenly collapse and succumb. Long railway journeys often destroy birds by being chilled. Sudden exertion on being let out after long confinement in a cage not rarely ends in death from heart failure or even from rapture of one of the large vessels or auricles of the heart. Birds with enlarged and softened livers not infrequently die from hæmorrhage by breaking down of the liver substance.

Birds require exercise, fresh air, and a suitable shelter, and the ground surface of the aviary, the nesting boxes, the perches and the food and water utensils should be kept scrupulously clean. The ground surface should be scraped and sprinkled with freshly-slacked lime. Stagnant pools or pond water should be avoided so as not to introduce parasites (*syngamus*, *trichostrongylus*, *capillaria*, *tænia*) which invade a very large number of the avian species, whether in confinement or at liberty.

Highly infectious diseases are often introduced by freshly acquired birds from an infected bird shop, bird room, aviary, or a show. They are often introduced by birds arriving from the Continent. Not infrequently an unscrupulous fancier, finding he has disease in his bird room or aviary, rushes them to an unwary dealer, or disposes of them to individuals. The purchase of second-hand cages or aviaries that have not been thoroughly cleansed and disinfected is often followed by a disastrous malady. Cages in which diseased or dead birds have been should either be burnt, or at least sterilised. All freshly acquired birds should be quarantined in separate thoroughly cleansed and sterilised cages for at least a month. Some birds may have all the appearances of good health, and yet may remain carriers. Certain birds after several weeks' quarantine may develop the infection that has remained latent so long. Decimating diseases are not rarely transmitted from bird to bird by the agency of insect life, such as flies, bugs, ticks, lice and mites. Rats and mice, as well as other small animals, may introduce disease by their soiled feet to a clean aviary. The same may be said of people who have

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soiled their boots in an infected aviary, and then gone into clean premises. Seeds and other foods purchased at a shop where diseased birds have been may introduce an infectious disease.

Bird keepers who rarely introduce fresh or outside stock on to their premises generally remain free from devastating diseases. Outdoor aviaries may have disease introduced by wild birds at liberty. Birds are attacked by the same classes of disease caused by similar or analogous or homologous parasites, microbes or viruses, as affect man and other animals. Living under similar conditions, all are liable to similar or homologous maladies. Some affections are, however, more common or prevalent in one species than in another. This is probably due to the conditions under which they are kept or maintained.

The study of bird pathology is not only interesting and instructive, but it has a great bearing on the pathology and therapeutics of man and other animal species. It should not be overlooked that Pasteur, more than fifty years ago, revolutionised medicine by his study of fowl cholera, and before that by those of the diseases of wine, beer, grape-vine disease, the silkworm disease, etc.

SALMONELLA INFECTIONS IN PIGEONS AND CAGE BIRDS: A REVIEW.

By A. B. ORR, B.Sc., M.R.C.V.S.

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INFECTION by members of the Salmonella group of organisms is responsible for considerable losses among cage birds and pigeons; a number of such cases having been encountered by the Department of Pathology, it was felt that a review of the literature on this subject would be of value.

The first reported case of Salmonella infection in cage birds appears to be that of Nocard (1893), who described an infectious enteritis of parrots, due to *B. aertrycke* (under the name of *B. psittacosis*). Miessner and Schern (1908) investigated an infectious disease of canaries which they named "infectious necrosis," on account of the necrotic areas found in the livers of affected birds; they isolated a short, round-ended, gram-negative, non-motile rod. Adam and Meder (1912) described the cultural and serological properties of *B. paratyphosus B*, which they isolated from three diseased canaries: the strain proved virulent for canaries, mice, guinea-pigs and rabbits. More recently Harkins (1926) recorded an outbreak of disease among canaries due to *B. paratyphosus B*, which was isolated from the heart blood, spleen and intestine of the affected birds. *B. enteritidis* (Breslau) was found in the organs and heart blood of canaries suffering from an acute infectious disease by Berge (1927). *B. aertrycke* was isolated from the heart blood of canaries by Beaudette and Edwards (1926). *B. enteritidis* (Breslau) was discovered as the cause of an enzootic in pigeons by Beck and Meyer (1927). Cornell (1928) has recorded

FIG. 1

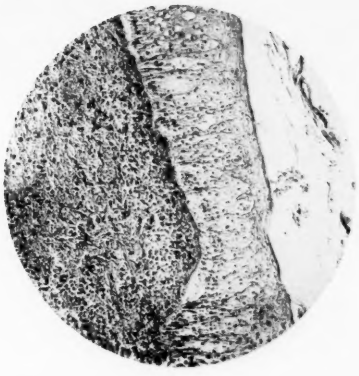

FIG. 2

Fig. 1.—Myxomatous degeneration with hypertrophied stellate cells, epithelioid cells and congested capillaries. Acid hæmalum and eosin. C.B. × 100.

Fig. 2.—Epidermis and cutis vera from a myxomatous mass: the cutis vera is infiltrated with polymorphonuclear leucocytes, hypertrophied fibroblasts and mononuclear cells; the epidermis is infiltrated with polymorphonuclear leucocytes, but acidophilic inclusions are absent. Heidenhain's iron hæmatoxylin and eosin. C.B. × 100.

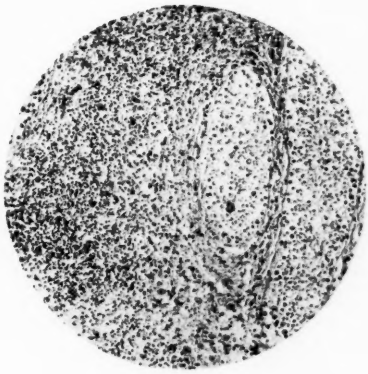

FIG. 3

Fig. 3.—Acute interstitial orchitis: infiltration with stellate cells, mononuclears and polymorphonuclear leucocytes; degeneration of the seminiferous tubules. Mayer's hæmalum and eosin. C.B. × 100.

"Infectious Myxomatosis of Rabbits," by G. M. Findlay (*see page* 550).

FIG. 1

FIG. 2

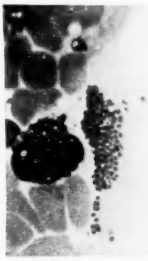

FIG. 3

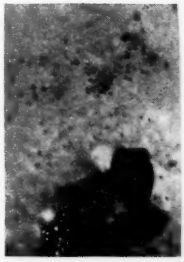

FIG. 4

"The Nature of the Virus of Psittacosis," by S. P. Bedson (*see page* 565).

Fig. 1.—Imprint preparation of mouse spleen. Shows plaque of virus material in which primary division is just beginning. One of the portions at the southern end of the plaque has been partially separated in making the preparation. Giemsa. Orange G.—Tannin. × 1200.

Fig. 2.—Imprint preparation of mouse spleen. Shows large mononuclear containing a primary morula which has been partly disrupted in making the preparation. Giemsa. Orange G.—Tannin. × 1200.

Fig. 3.—Imprint preparation of mouse spleen. Shows a clump of virus lying free containing large and intermediate divisional forms. Giemsa. Orange G.—Tannin. × 1200.

Fig. 4.—Imprint preparation of mouse spleen. Shows numerous elementary bodies lying free. Giemsa. Orange G.—Tannin. × 1200.

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a case of infectious necrosis of canaries caused by an organism which appears to be a member of the typhoid-dysentery group ; it is described as a short gram-negative bacillus with rounded ends, somewhat pleomorphic and non-motile, and produces acid, but no gas in glucose, lævulose, maltose, mannite and arabinose ; lactose, saccharose, inulin, dulcite, salicin, glycerine, and litmus milk were not affected, and indole was not produced ; further identification by means of agglutination absorption tests was not recorded. *B. aertrycke* infection in canaries has also been reported by Martinaglia (1928), while Lahaye and Willems (1930), Cash and Doan (1930), and Clarenburg and Dornickx (1932) have identified the same organism as the cause of natural infection in pigeons.

Epidemiology.—Infection with organisms of the Salmonella group in cage birds and pigeons is very widespread. It has been recorded in England, Germany and America. The disease usually takes the form of an acute septicæmia with a high mortality rate. Gray (1910) recorded his clinical observations, and emphasised the high mortality in cage birds infected with these organisms. Harkins gave the mortality in canaries affected with *B. paratyphosus B* as 74.5 per cent., and Lahaye and Willems stated that at least 60 per cent. of cases of *B. aertrycke* infection proved fatal in young pigeons.

Symptomatology.—The symptoms recorded by various observers are very similar. There is first drowsiness, depression and loss of appetite ; the feathers become ruffled and the breathing is accelerated. The bird becomes emaciated and diarrhœa appears, followed rapidly by death. The time between the onset of symptoms and death is short ; Harkins stated that in canaries affected with *B. paratyphosus B* the approximate time is thirty-six hours ; other observers give periods of from one to four days. Sometimes the attack is so acute that the bird dies without showing any symptoms beyond accelerated respiration. On the other hand, a few may linger on for days, eventually dying in a state of extreme emaciation. Lahaye and Willems stated that the majority of pigeons surviving the acute stage of *B. aertrycke* infection show a chronic form of the disease in which there is general ill-health frequently followed by the appearance of arthritis. The latter symptom is of interest in that Emmel (1929) has recorded an arthritis of a chronic type in pigeons due to *S. schotmulleri.*

Post-mortem Findings.—The post-mortem findings in acute Salmonella infections are generally confined to the liver, spleen and intestine.

In canaries, the naked-eye and histological changes have been described by Miessner and Schern, by Beck and Huck (1925), and by Cornell. The liver and spleen were markedly enlarged, and showed large numbers of pin-head to millet-seed sized yellowish-white foci, which on microscopic examination were found to consists of masses of bacteria. The larger foci showed a centre composed of dead cells and bacteria, and immediately around each nodule was a zone of degenerating spleen cells, among which there were many leucocytes containing phagocyted bacilli. Grey referred to nodular lesions occurring in the spleen, liver, and

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sometimes the lungs. Berge found slight congestion of the intestine, a swollen, dark-red, and rather soft spleen, and a brownish-red and slightly swollen liver.

In pigeons, Lahaye and Willems found whitish, rather dull pin-head sized foci in the liver, but rarely in the spleen. Similar foci were found less constantly in the kidneys. There was usually a pneumonia, involving as a rule only one lung. In pigeons more than fifteen days old there occurred, in addition, necrotic foci in the pancreas, arthritis, and ulceration of the intestine. The ulcers, which were situated in the anterior part of the intestine, were elongated in shape, with their long axis at right angles to that of the gut. Cash and Doan recorded their post-mortem findings in the case of *B. aertrycke* infection in pigeons. There was marked enlargement of the liver and kidneys, which contained numerous small yellowish-grey foci of perivascular myelocytic infiltration. The sinusoids of the liver contained many large mononuclear phagocytes and bacteria. The spleen, which was also enlarged, showed a marked increase of large clear mononuclear phagocytic cells associated with large numbers of *B. aertrycke*; there was an almost complete absence of lymphoid tissue, and no perivascular infiltration of myelocytes, as in the liver and kidneys. An extreme myeloid hyperplasia of the bone-marrow was also present. The other organs of the body appeared normal.

Treatment.—The treatment of Salmonella infections resolves itself into attempts to limit the spread of the outbreak. In the first place all the in-contact birds must be regarded as possible sources of infection, and therefore none of them should be transferred to other aviaries or to other sections of the same aviary which contain uninfected stock. Cages which have housed infected birds should be rigidly disinfected, and feeding utensils should be sterilised daily. Droppings must be collected and burnt, and every effort made to prevent the transference of infective objects or material from affected birds to healthy ones. No attempt to control the disease by means of an anti-serum is to be found in the literature; but in the absence of a specific serum prepared from a strain of Salmonella isolated from affected cage birds, it is suggested that the value of stock *B. aertrycke* and *B. paratyphosus B* anti-sera might be tested.

Clinically affected birds and "carriers" may be detected by the agglutination test; 1 : 50 being regarded as a positive titre (Schutt, 1931). Agglutinins appear on the sixth day following experimental infection. (Reinholdt, 1912.)

It is not improbable that some of these epizootics of pigeons and cage birds are primarily due to a filtrable virus with the Salmonella organism acting as a secondary invader.

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THE NATURE OF THE VIRUS OF PSITTACOSIS.

By S. P. BEDSON.

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WHEN one considers the previous attempts to identify the causal agent of psittacosis, one is surprised at the readiness with which the claims of Nocard's bacillus were accepted. It is true that *B. psittacosis* was isolated from parrots dead of this disease, and that it was capable of producing a fatal illness in birds of this species, but subsequent attempts to provide confirmation of the ætiological significance of this organism had not resulted in anything in the least convincing. It was not surprising therefore, that, when in the recent epidemic of 1929–30 cases began to arrive at the London Hospital, and the question of an accurate diagnosis had to be faced, both clinician and laboratory worker alike experienced considerable doubt as to the ætiological significance of *B. psittacosis*. It was known then, of course, that *B. psittacosis* was none other than *B. aertryke*, and this alone was sufficient to cast doubt on its claims. In man, infection with *B. aertrycke* usually takes the form of an acute gastro-enteritis, only rarely does it produce a clinical state resembling typhoid fever. This was not in keeping with the clinical picture presented by psittacosis. But quite apart from this, there was the extreme readiness with which the disease passed from parrot to man. In many cases infection occurred merely after going into the room containing the diseased parrot ; direct contact with the bird or its cage was not necessary. Such a high degree of infectivity resembles what occurs in the case of *B. tularense*, but finds no parallel in infections caused by *B. aertrycke*, or any of the Salmonellas. Thus it was that the investigation at the London Hospital started with the assumption that the ætiological agent of psittacosis had yet to be found. The solution to the problem was not long in forthcoming. Neither in parrot nor in man suffering from this disease was any evidence obtained that the infective agent was either *B. aertrycke* or any other cultivable bacterium, but the constant presence of a filtrable virus was demonstrated (Bedson, Western, and Levy Simpson, 1930), an observation that soon received confirmation from independent sources (Krumweide, McGrath and Oldenbusch, 1930 ; Levinthal, 1930 ; Gordon, 1930 ; Elkeles, 1930). Shortly after the discovery that the virus of psittacosis was filtrable, it was announced that suitably stained preparations of virulent material contained numerous minute coccus-like particles which had the appearance of micro-organisms (Coles, 1930 ; Levinthal, 1930 ; Lillie, 1930). Coles, who was possibly the first to see these bodies, gave them the non-committal name

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of X bodies, though he was of the opinion that they were micro-organisms. Lillie remarked their resemblance to rickettsia, and proposed the name *Rickettsia psittaci*, whilst Levinthal (1930), who was impressed by the pleomorphism presented by these particles, named the virus *Microbacterium multiforme psittacosis*. These minute bodies stain with greater difficulty than the ordinary bacteria, though more readily than the elementary bodies of other filtrable viruses, such as the Paschen and Borrel bodies. In smear preparations they can be demonstrated by prolonged staining with Giemsa or by Rivers' modification of Castaneda's stain (Rivers and Berry, 1931), the latter method having the advantage of rapidity. In formalin-fixed tissue, they stain readily with Giemsa, methylene blue eosin, or toluidine blue eosin orange, the virus taking a blue-purple colour. Although in smears they occur both free and inside cells, in sections their position is intra-cellular, where they form compact masses, sometimes occupying the major portion of the infected cell. No accurate measurement has been made of these bodies, but they are probably about 0.2–0.25$_{\mu}$ in size. It should be pointed out that at the time when Levinthal and Lillie suggested their names for this virus, the connection between these bodies and the virus was by no means established. Although they had been demonstrated in material from a variety of sources, their presence was not constant. Whereas in experimentally infected mice they occurred with great regularity, in human and avian material of known virulence it was frequently impossible to find them. However, the filter and centrifuge experiments of Bedson and Western (1930) pointed to the virus being represented by particles of a considerable size, and gave colour to the view that the bodies seen in stained preparations were in fact the virus. Further than this, the ease with which the virus could be thrown down by centrifugation, revealed by these experiments, suggested the possibility of spinning out the virus, and washing it as one would a bacterium, and so obtaining it in a relatively pure state. This suggestion was fully realised in subsequent experiments. The thrice-washed deposit obtained from a suspension of virulent mouse spleen was found to possess the virulence of the crude suspension, and to consist almost entirely of minute bodies, whose size, shape, and tinctorial affinities were those of the bodies seen in direct smears of virulent material. In addition, these washed virus particles could be specifically agglutinated by an anti-psittacosis serum and fixed complement in its presence (Bedson, 1932). Thus it was shown that the virulence of a suspension of psittacosis material resided in the minute bodies. The reasonable interpretation of these results would be that the minute bodies were the virus ; in other words, that the virus was a small micro-organism. But there still existed a possible loophole of escape from this conclusion, that those who were averse to micro-organismal conception of filtrable viruses made use of. It was conceivable, they argued, that the particles were of cellular origin, and that the virus was merely adsorbed on them. The inability to cultivate the virus of psittacosis in a lifeless medium rendered it difficult to refute this argument, but more recent work has helped materially in this direction. In previous work on psittacosis virus, morphological studies had been confined to material from

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dead or dying animals, and the eye was focussed on the minute or elementary bodies. It is not difficult to understand why this should have been. Experimental animals are either allowed to die, or killed when moribund, because one expects thus to get a greater yield of virus. And by analogy from what is known of other filtrable viruses, one would not anticipate finding any other form than the elementary bodies. No published account of psittacosis virus contained any suggestion that it ever departed from the forms of elementary bodies. Certainly the name *Microbacterium multiforme psittacosis*, devised by Levinthal, implied some degree of pleomorphism, but nothing more than this, and in our own studies the elementary bodies were the only forms which had been recognised as virus particles. It was felt, however, that before accepting the elementary body as the whole story, it would be as well to examine the virus in the early stages of development. This study was made in the mouse, using a strain of virus whose virulence had been raised to a high degree by repeated passage in that animal. The development of the virus was followed in spleens removed at varying intervals after inoculation, and the findings have formed the subject of a recent communication (Bedson and Bland, 1932). They showed quite clearly that psittacosis virus was not always in the form of elementary bodies, and the different forms showed such a regular sequence, both in morphology and in time, as to suggest that the virus passed through a developmental cycle. In the earliest spleens examined, *i.e.*, from five to twelve hours after inoculation, no particulate forms could be made out, but homogeneous masses having the staining affinities of the virus could be discerned. These plaques of virus varied in size and shape. Later, from twelve to fifteen hours after inoculation, the plaques appeared to be undergoing division (Fig. 1), the resultant particles being over 1_{μ} in size, and not regularly oval or circular in shape, but facetted and angular (Fig. 2). These primary divisional forms then divided, giving rise to smaller forms (Fig. 3), and from these, by further division and sub-division, smaller and smaller forms arose, until at forty-eight hours after inoculation practically all the virus was in the form of elementary bodies (Fig. 4). This cycle of change occurred regularly, and was observed both in preparations made from spleen of inoculated mice and in tissue cultures made either with mouse spleen removed five hours after inoculation, or with normal mouse spleen infected *in vitro*. Similar forms were not observed in uninoculated mice, and cultural tests showed that contaminating bacteria were absent. Two interpretations of these findings seem possible. The virus might be a bacterium which in the early stages of multiplication gives rise to much larger forms than normal, a return to normal size, that of the elementary body, occurring as multiplication proceeds. The plaques would then represent colonies of large forms which were enveloped in some material, possibly mucoid material, which they themselves had secreted, and which disappeared in the later stages of multiplication. The other interpretation, and the one to which we incline (Bedson and Bland, 1932), is that the plaque is a plasmodium resulting from the fusion of smaller masses which arise from elementary bodies. Appearances seen in early spleens suggest that this does in fact take

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place, although admittedly it is a point which it is difficult to be certain of. At a given stage of maturity the plasmodium divides into a number of more or less equal portions, giving rise to what might be termed a morula. Each of the large forms constituting the primary morula then divides and subdivides, producing morulæ of progressively smaller forms until the size of the elementary bodies is reached. The whole cycle takes place intracellularly, and occupies about forty-eight hours. Such an interpretation would imply that this virus was not a bacterium, but possessed affinities with the myxomycetes or mycetozoa, or possibly the microsporidia. Admittedly the evidence so far is purely morphological, and further experimental work will be required before this can be fully appreciated and given its correct interpretation. It will be recognised, however, that to settle with certainty whether this virus is a bacterium or a protozoan will be a matter of considerable difficulty if not of impossibility. It is doubtful even if the question is of very great importance. The importance of the work lies rather in other directions. It demonstrates that a filtrable virus is not necessarily always in the form of minute elementary bodies, and further it gives overwhelming support to the conception that psittacosis virus is an organised living thing. The interpretation of these findings on any other basis would require a mental ingenuity pushed to the extreme of absurdity.

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